SCIENCE

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THE HISTORY OF ICHTHYOLOGY.*

SCIENCE consists of human experience, tested and placed in order. The science of ichthyology contains our knowledge of fishes, derived from varied experience of man, tested by methods or instruments of precision and arranged in orderly sequence. This science, in common with every other, is the work of many men, each in his own field, and each contributing a series of facts, a series of tests of the alleged facts of others, or some improvement in the method of arrangement. As in other branches of science, this work has been done by sincere, devoted men, impelled by a love for this kind of labor, and having in view, as 'the only reward they asked, a grateful remembrance of their work.' And in token of this reward it is well sometimes, in grateful spirit, to go over the names of those who made even its slight degree of completeness possible.

We may begin the history of ichthyology with that of so many others of the sciences, with the work of Aristotle (383–322 B.C.). This wonderful observer recorded many facts concerning the structure and habits of the fishes of Greece, and in almost every case his actual observation bears the closest modern test. These observations

* Address of the Vice-President and Chairman of Section F, Zoology, American Association for the Advancement of Science, Pittsburgh Meeting, 1902.

were hardly 'set in order.' The number of species he knew was small, about 115 in all, and it did not occur to him that they needed classification. His ideas of species were those of the fishermen, and the changing vernacular supplied him with the necessary names.

As Dr. Günther wisely observes, 'It is less surprising that Aristotle should have found so many truths as that none of his followers should have added to them.' For about 1,800 years the scholars of the times copied the words of Aristotle, confusing them by the addition of fabulous stories and foolish superstitions, never going back to nature herself, 'who leads us to absolute truth whenever we wander.' A few observations were made by Caius Plinius, Claudius Ælianus, Athenæus and others. About 400 A.D. Decius Magnus Ausonius wrote a pleasing little poem on the Moselle, setting forth the merits of its various fishes. It was not, however, until the middle of the seventeenth century that any advance was made in the knowledge of fishes. At that time the development of scholarship among the nations of Europe was such that a few wise men were able to grasp the idea of species.

In 1553, Pierre Belon published his little book 'De Aquatilibus,' in which numerous (110) species of fishes of the Mediterranean were described, with tolerable figures, and with these is a creditable attempt at classification. At about this time Ulysses Aldrovandus, of Bologna, founded the first museum of natural history and wrote on the fishes it contained. In 1554, Salviani (1514–1572), a physician at Rome, published 'Aquatilium Animalium Historia,' with good figures of most of the species, together with much general information as to the value and habits of animals of the sea.

More important than these, but almost simultaneous with them, is the great work of Guillaume Rondelet (1507–1557), 'De Piscibus Marinis,' later published in French and enlarged under other titles. In this work the different species, 244 in all, chiefly from the Mediterranean, are fairly described, and the various fables previously current are subjected to severe scrutiny. Recognizable woodcuts represent the different species. Classification, Rondelet had none, except as simple categories for purposes of convenience. More than usual care is given to the vernacular names, French and Greek. He closes his book with these words.

"Or s'il en i a qui prennent les choses tant à la rigueur, qui ne veulent rien apparouver qui ne soit du tout parfait, je les prie de bien bon cueur de traiter telle, ou quelque autre histoire parfaitement, sans qu'il i ait chóse quelconque à redire et la receverons é haut louerons bien voluntiers. Cependant je sçai bien, et me console * * * avec grand travail * * * qu'on pourra trouver plusieurs bones choses é dignes de louange ou proufit é contentement des homes studieux é à l'honneur é grandissime admiration des tres excellens é perfaits œuvres de Dieu."

And with the many 'bones choses' of the work of Rondelet, men were long too well satisfied, and it was not until the impulse of commerce had brought men face to face with the new series of animals not found in the Mediterranean that the work of the science of fishes was again resumed. About 1640 Prince Moritz (Maurice), of Nassau, visited Brazil, taking with him two physicians, George Marcgrav and Wilhelm Piso. In the great work 'Historia Naturalis Brasiliæ,' published at Leyden, 1648, Marcgrav described about one hundred species, all new to science, with a good deal of spirit and accuracy. This work was printed by Piso after Marcgrav's death, and his colored drawings—long afterwards used by Bloch—are in the 'History of Brazil' reduced to small and crude woodcuts. This is the first study of a local fish

fauna outside the Mediterranean region, and it reflects great credit on Maregrav and on the illustrious prince whose assistant he was.

There were no other similar attempts of importance in ichthyology for a hundred years, when Per Osbeck, an enthusiastic student of Linnæus, published (1757) the records of his Chinese cruise under the name of 'Iter Chinensis.' At about the same time another of Linnæus' students, Hasselquist, published his 'Iter Palestinum,' the account of his discoveries of fishes in Palestine and Egypt. More pretentious than these and of much value, as an early record, is Mark Caterby's (1679–1749) 'Natural History of Carolina and the Bahamas,' published in 1749, with large colored plates, which are fairly correct except in those cases where the drawing was made from memory.

About this time, Hans Sloane (1660–1752) published his 'Fishes of Jamaica,' Patrick Browne (1720–1790) wrote on the fishes of the same region, while Father Charles Plumier (1646–1704) made paintings of the fishes of Martinique, long after used by Bloch and Lacépède. Dr. Alexander Garden, of Charleston, S. C., collected fishes for Linnæus, as did also Dr. Peter Kalm in his travels in the northern parts of the American Colonies.

With the revival of interest in general anatomy, several naturalists took up the structure of fishes. Among these Günther mentions Borelli, Malpighi, Swammerdam and Duverney.

The basis of classification was first fairly recognized by John Ray (1628–1705) and Francis Willughby (1635–1672), who, with other and varied scientific discoveries, undertook, in the 'Historia Piscium,' published in Oxford in 1686, to bring order out of the confusion left by their predecessors. This work, edited by Ray after Willughby's death, is ostensibly the work of Willughby with additions by Ray. In this work 420 species were recorded, 180 of these being actually examined by the authors, and the arrangement chosen by them paved the way to a final system of nomenclature.

Direct efforts in this direction, with a fairly clear recognition of genera as well as species, were made by Lorenz Theodor Gronow, called Gronovius, a German naturalist of much acumen, and by Jacob Theodor Klein (1685–1757), whose work, 'Historia Naturalis Piscium,' published about 1745, is of less importance, not being much of an advance over the catalogue of Rondelet.

Far greater than any of these investigators was he who has been justly called the father of ichthyology, Petrus Artedi (1705–1734).

He was born in Sweden, was a fellow student of Linnæus at Upsala, and devoted his short life wholly to the study of fishes. He went to Holland to examine the collection of East and West Indian fishes of a rich Dutch merchant in Amsterdam, named Seba, and there at the age of twenty-nine he was, by accident, drowned in one of the canals. 'His manuscripts were fortunately rescued by an Englishman, Cliffort,' and they were edited and published by Linnæus in a series of five parts or volumes.

Artedi divided the classes of fishes into orders, and these orders again into genera, the genera into species. The name of each species consisted of that of the genus with a descriptive phrase attached. This cumbersome system, called polynomial, was a great advance on the shifting vernacular, which in the works of Artedi, Gronow, Klein and others, it was now replacing. But the polynomial system as a system was of short duration. Linnæus soon substituted for it the very convenient binomial system which has now endured for 150

years, and which, with certain modification, must form the permanent substructure of the nomenclature in systematic zoology.

The genera of Artedi are in almost all cases natural groups, although essentially equivalent to the families of to-day, a division which in ichthyology was first clearly recognized by Cuvier.

The following is a list of Artedi's genera and their arrangement:

ORDER MALACOPTERYGII.

Syngnathus (pipe-fishes) (4 species).
Cobitis (loaches) (3).
Cyprinus (carp and dace) (19).
Clupea (herrings) (4).
Argentina (argentines) (1).
Exocœtus (flying-fishes) (2).
Coregonus (white fishes) (4).
Osmerus (smelts) (2).
Salmo (salmon and trout) (10).
Esox (pike) (3).
Echeneis (remoras) (1).
Coryphæna (dolphins) (3).
Ammodytes (sand launces) (1).
Pleuronectes (flounders) (10).
Stromateus (butter-fishes) (1).
Gadus (cod-fishes) (11).
Anarhichas (wolf-fishes) (1).
Muræna (eels) (6).
Ophidion (cusk-eels) (2).
Anableps (four-eyed fish) (1).
Gymnotus (carapos) (1).
Silurus (cat-fishes) (1).

ORDER ACANTHOPTERYGII.

Blennius (blennies) (5).
Gobius (gobies) (4).
Xiphias (sword-fishes) (1).
Scomber (mackerels) (5).
Mugil (mullets) (1).
Labrus (wrasses) (9).
Sparus (porgies) (15).
Sciæna (croakers) (2).
Perca (perch and bass) (7).
Trachinus (weavers) (2).
Trigla (gurnards) (10).
Scorpæna (scorpion-fishes) (2).
Cottus (sculpins) (5).
Zeus (john dories, etc.) (3).
Chætodon (butterfly-fishes) (4).
Gasterosteus (stickle-backs) (3).
Lepturus (cutlass-fishes) (=*Trichiurus*) (1).

ORDER BRANCHIOSTEGI.

Balistes (trigger-fishes) (6).
Ostracion (trunk-fishes) (22).
Cyclopterus (lump-fishes) (1).
Lophius (anglers) (1).

ORDER CHONDROPTERYGII.

Petromyzon (lampreys) (3).
Acipenser (sturgeons) (2).
Squalus (sharks) (14).
Raja (rays) (11).

In all 47 genera and 230 species of fishes were known from the whole world in 1738.

The cetaceans, or whales, constitute a fifth order, Plagiuri, in Artedi's scheme.

As examples of the nomenclature of species I may quote:

'*Zeus ventre aculeato, cauda in extremo circinata.*' This polynomial expression was shortened by Linnæus to *Zeus faber*. The species was called by Rondelet 'Faber sive Gallus Marinus' and by other authors '*Piscis jovii.*' 'Jovii' suggested *Zeus*, and Rondelet's name, *faber*, was the specific name chosen by Linnæus.

'*Anarhichas Lupus marinus nostras.*' This became with Linnæus '*Anarhichas lupus.*'

'Clupea, maxilla inferiore longiose, maculis nigris carens: Harengus vel Chalcis Auctorum, Herring vel Hering Anglis, Germanis, Belgis.' This became *Clupea harengus* in the convenient binomial system of Linnæus.

The great naturalist of the eighteenth century, Carl von Linné, known academically as Carolus Linnæus, was the early

associate and close friend of Artedi, and from Artedi he obtained practically all his knowledge of fishes. Linnæus, the head of the University of Upsala, primarily a botanist, was a man of wonderful erudition, and his great strength lay in the orderly arrangement of things. In his lifetime, his greatest work, the 'Systema Naturæ,' passed through twelve editions. In the tenth edition, in 1758, the binomial system of nomenclature was first consistently applied to all animals. For this reason, most naturalists use the date of its publication as the beginning of zoological nomenclature, although the English naturalists have generally preferred the more complete twelfth edition, published in 1766. This difference in the recognized starting point has been often a source of confusion, as in several cases the names of species were needlessly changed by Linnæus and given differently in the twelfth edition.

In Linnæus' system (tenth and twelfth editions), all of Artedi's genera were retained save *Lepturus,* which name was changed to *Trichiurus.* The following new genera were added: *Chimæra, Tetraodon, Diodon, Centriscus, Pegasus, Callionymus, Uranoscopus, Cepola, Mullus, Teuthis, Loricaria, Fistularia, Atherina, Mormyrus, Polynemus, Amia, Elops.* The classification was finally much altered; the Chondropterygia and Branchiostegi (with *Syngnathus*) being called *Amphibia Nantes,* and divided into 'Spiraculis compositis' and 'Spiraculis solitariis.' The other fishes were more naturally distributed according to the position of the ventral fins into Piscis Apodes, Jugulares, Thoracici and Abdominales. The Apodes do not form a homogeneous group, as members of various distinct groups have lost their ventral fins in the process of evolution. But the Jugulares, the Thoracici and the Abdominales must be kept as valid categories in any natural system.

Linnæus's contributions to zoology consisted mainly of the introduction of his most ingenious and helpful system of bookkeeping. By it naturalists of all lands were able to speak of the same species by the same name in whatever tongue. Unfortunately, ignorance, carelessness and perversity brought about a condition of confusion. For a long period many species were confounded under one name. This began with Linnæus himself. On the other hand, even with Linnæus, the same species often appeared under several different names. In this matter it was not the system of naming which was at fault. It was the lack of accurate knowledge, and sometimes the lack of just and conscientious dealing with the work of other men. No system of naming can go beyond the knowledge on which it rests. Ignorance of fact produces confusion in naming. The earlier naturalists had no conception of the laws of geographical distribution. The 'Indies,' East or West, were alike to them, and 'America' was a sufficiently exact record of the origin of any specimen.

Moreover, no thought of the geological past of groups and species had yet arisen, and, without the conception of common origin, the facts of homology had no significance. All classification was simply a matter of arbitrary pigeon-holing the records of forms, rather than an expression of actual blood-relationship. To this confusion much was added through love of novelty. Different authors changed names to suit their personal tastes, regardless of rights of priority. *Amia* was altered to *Amiatus* because it was too short a name. *Hiodon* was changed to *Amphiodon* because it sounded too much like *Diodon,* and other changes much more wanton were introduced, to be condemned and discarded by the more methodical workers of a later period. With all its abuses, however, the binomial nomenclature made possible sys-

tematic zoology and botany, and with the 'Systema Naturæ' arose a new era in the science of living organisms.

In common with most naturalists of his day, the spirit of Linnæus was essentially a devout one. Admiration for the wonderful works of God was breathed on almost every page. 'O Jehovah! quam ampla sunt opera Tua' is on the title-page of the 'Systema Naturæ,' and the inscription over the door of his home at Hammarby was, to Linnæus, the wisdom of his life. This inscription read: 'Innocue vivito: Numen adest' (Live blameless: God is here).

The followers of Linnæus are divided into two classes, explorers and compilers. To the first class belonged his own students and others who ransacked all lands for species to be added to the lists of the 'Systema Naturæ.' These men, mostly Scandinavian and Dutch, worked with wonderful zeal, enduring every hardship and making great contributions to knowledge, which they published in more or less satisfactory forms. To these men we owe the beginnings of the science of geographical distribution. Among the most notable of these are Per Osbeck and Frederick Hasselquist, already noted; Otto Fabricius, author of a 'Fauna of Greenland'; Carel Thunberg, successor of Linnæus as head of the University of Upsala, who collected fishes about Nagasaki, entrusting most of the descriptive work to the less skillful hands of his students Jonas Nicolas Ahl and M. Houttuyn, Martin Th. Brunnich, who collected at Marseilles the materials for his 'Pisces Massiliensis'; Petrus Forskål, whose work on the fishes of the Red Sea (Descriptio Animatium,' etc.), published posthumously in 1775, is one of the most accurate of faunal lists, and one which shows a fine feeling for taxonomic distinctions, scarcely traceable in any previous author. George Wilhelm Steller, naturalist of Bering's expedition, gathered amid incredible hardships the first knowledge of the fishes of Alaska and Siberia, his notes being printed after his tragic death, by Pallas and Krascheninnikow. Petrus Simon Pallas gives the account of his travels in the North Pacific in his most valuable volumes, 'Zoographia Russo-Asiatica.' S. T. Gmelin and Güldenstadt, like Steller, crossed Siberia, recording its animals. Johann David Schöpf, a Hessian surgeon stationed at Long Island in the Revolutionary War, gave an excellent account of the fishes about New York.

Other naturalists accompanied navigators around the globe, collecting specimens and information as opportunity offered. John Reinhold Forster and Solander sailed with Captain Cook. Commerson accompanied Bougainville and furnished nearly all the original material used by Lacépède. Other noted travellers of the early days were Sonnerat and Mungo Park.

Still other naturalists, scarcely less useful, gave detailed accounts of the fauna of their own native regions. Ablest of these was Anastole Risso, an apothecary of Nice, who published in 1810 the 'Ichthyologie de Nice,' an excellent work afterwards (1826) expanded by him into a 'Histoire Naturelle d'Europe Meridionale.'

Contemporary with Risso was a man of opposite character, Constantine Samuel Rafinesque (1784–1842), who wrote at Palermo in 1810 his 'Caratteri di Alcuni Nuovi Generi' and 'Ittiologia Sciliana.' Later he went to America, where he was for a time professor in the Transylvania University in Kentucky. Brilliant, erudite, irresponsible, fantastic, he wrote of the fishes of Sicily and later ('Ichthyologia Ohiensis,' 1820) of the fishes of the Ohio River, with wide knowledge, keen taxonomic insight and a hopeless disregard of the elementary principles of accuracy. Always eager for novelties, restless and credulous, his writings have been among the most diffi-

cult to interpret of any in ichthyology. Earlier than Risso and Rafinesque, Thomas Pennant wrote of the British fishes, Oscar Fredrik Müller of the fishes of Denmark, J. E. Gunner, Bishop of Thröndhjem, of fishes of Norway, Duhamel du Monceau of the fisheries of France, D. J. Cornide of the fishes of Spain, and Meidinger of those of Austria. Most of these writers knew little of the Linnæan system, and their records are generally in the vernacular. Most important of this class is the work of Antonio Parra, 'Descripcion de Diferentes Piezas de Historia Natural de la Isla de Cuba,' published in Havana in 1787. In 1803, Patrick Russell gave a valuable account of 'Two Hundred Fishes Collected at Vizagapatam and on the Coast of Coromandel.' Following this was a work on the fishes of the Ganges, well illustrated, by Francis Buchanan-Hamilton.

Bering Sea and Japan were explored by William Theophilus Tilesius (1775–1835), whose papers are published in the transactions of the early societies of Russia. Stephan Krascheninikov (1786) wrote a history of Russia in Asia, and other geographical writers, as Krüsenstern, contributed something to our knowledge of the fishes in regions visited by them.

Other notable names among the early writers are those of Auguste Broussonet, of Montpelier, whose work, too soon cut short, showed marked promise, B. A. Euphrasen, Fr. Faber, who wrote of the fishes of Iceland, Everard Home, E. Blyth, who studied the fishes of the Andamans, J. T. Kölreuter, J. Lepechin, John Latham, W. E. Leach, A. G. Desmarest, G. Montague, C. Quensel, H. Storm and M. Vahl.

The compilers who followed Linnæus belonged to a wholly different class. These were men of large learning, methodical ways, sometimes brilliant, sometimes of deep insight, but more often, on the whole, dull, plodding and mechanical.

Earliest of these is Antoine Goüan, whose 'Historia Piscium' was published in Paris in 1770. In this work, which is of fair quality, only genera were included, and the three new ones which he introduces into the 'System' (*Lepadogaster*, *Lepidopus* and *Trachypterus*) are still retained with his definition of them.

Johann Friedrich Gmelin published in 1788 a thirteenth edition of the 'Systema Naturæ' of Linnæus, adding to it the discoveries of Forskål, Forster and others who had written since Linnæus' time. This work was useful as bringing that of Linnæus to a later date, but it is not well done, the compiler having little knowledge of the animals described and little penetration in matters of taxonomy. Very similar in value, although more lucid in expression, is the French compilation of the same date (1788), 'Tableau Encyclopédique et Méthodique des Trois Règnes de la Nature,' by the Abbé J. P. Bonnaterre. Another 'Encyclopédie Méthodique,' of still less merit, was published as a dictionary in Paris in 1787, by Réné Just Haüy.

In 1792, Johann Julius Walbaum, a German compiler of a little higher rank, gathered together the records of all known species, using the work of Artedi as a basis, and giving binomial names in place of the vernacular terms used by Schöpf, Steller, Pennant and Krascheninnikow.

Far more pretentious and more generally useful, as well as containing a large amount of original material, is the 'Ichthyologia' of Mark Eliezer Bloch, published in Berlin in various parts from 1782 to 1795. It was originally of two parts in German, 'Oeconomische Naturgeschichte der Fische Deutschlands' and 'Naturgeschichte der Ausländischen Fische.' Bloch was a physician, born at Anspach in 1723, and at the age of fifty-six began to devote himself to ichthyology. In his great work is contained every species which he had himself seen,

every one which he could purchase from collections, and every one of which he could find drawings made by others.

That part which relates to the fishes of Germany is admirably done. In the treatment of East Indian and American fishes there is much guess work, and many errors of description and of fact, for which the author was not directly responsible. To learn to interpret the personal equation in the systematic work of other men is one of the most delicate of taxonomic arts.

After the publication of these great folio volumes of plates, Dr. Bloch began a systematic catalogue to include all known species. This was published after his death by his collaborator, the philologist, Dr. Johann Gottlob Schneider. This work, 'Systema Ichthyologiæ M. E. Blochii,' contains 1,519 species of fishes, and is the most creditable compilation subsequent to the death of Linnæus.

Even more important than the work of Bloch is that of the Comte de Lacépède, who became with the progress of the French Revolution 'Citoyen Lacépède,' his original full name being Bernard Germain Etienne de la Ville-sur-Illon, Comte de Lacépède. His great work, 'Histoire Naturelle des Poissons,' was published originally in five volumes, in Paris, from 1798 to 1803. It was brought out under great difficulties, his materials being scattered, his country in a constant tumult. For original material he depended chiefly on the collection and sagacious notes of the traveler Commerson. Dr. Gill sums up the strength and weakness of Lacépède's work in these terms:

"A work by an able man and eloquent writer even prone to aid rhetoric by the aid of the imagination in absence of desirable facts, but which because of undue confidence in others, default of comparison of material from want thereof and otherwise, and carelessness generally, is entirely unreliable."

The work of Lacépède had a large influence upon subsequent investigators, especially in France. A large portion of the numerous new genera of Rafinesque was founded on divisions made in the analytical keys of Lacépède.

In 1803 and 1804, Dr. George Shaw published in London his 'General Zoology,' the fishes forming part of Volumes IV. and V. This is a poor compilation, the part concerning the fishes being largely extracted from Bloch and Lacépède. In 1807, Constant Duméril published an analytical table of classification of some merit as 'Ichthyologie Analytique,' and about 1815, H. Ducrotay de Blainville wrote the 'Faune Française' and contributed important studies to the taxonomy of sharks.

With Georges Chrétien Léopold Dagobert Cuvier and the 'Règne Animal Arrangé après son Organization' (1817–1826) we have the beginning of a new era in ichthyology. This period is characterized by a recognition of the existence of a natural classification based on the principles of morphology. The 'Règne Animal' is, in the history of ichthyology, not less important than the 'Systema Naturæ' itself, and from it dates practically our knowledge of families of fishes, and the interrelations of the groups themselves. The great facts of homology were clearly understood by Cuvier. Their significance as indications of lines of descent was never grasped by him, and this notwithstanding the fact that Cuvier was almost the first to bring extinct forms into the proper relations with those now living.

Dr. Günther well says that the investigation of anatomy of fishes was continued by Cuvier until he had succeeded in completing so perfect a framework of the system of the whole class that his immediate

successors could content themselves with filling up those details for which their master had no leisure. Indefatigable in examining all the external and internal characters of the fishes of a rich collection, he ascertained the natural affinities of the infinite variety of fishes, and accurately defined the divisions, orders, families and genera of the class, as they appear in the various editions of the 'Règne Animal.' His industry equaled his genius; he opened connections with almost every accessible part of the globe; not only French travelers and naturalists, but also Germans, Englishmen, Americans, rivaled one another to assist him with collections; and for many years the Museum of the Jardin des Plantes was the center where all ichthyological treasures were deposited. Thus Cuvier brought together a collection the like of which had never been seen before, and which, as it contains all the materials on which his labors were based, must still be considered to be the most important.

The greatest contributions of Cuvier to ichthyology are contained in the great 'Histoire Naturelle des Poissons,' the joint work of Cuvier and his pupil and successor, Achille Valenciennes. Of this work 22 volumes were published, from 1828 to 1847, containing 4,514 nominal species, the larger number of volumes appearing after the death of Cuvier (1832), the work closing, not quite complete, with the death of Valenciennes in 1848.

This is a most masterly work, still indispensable to the student of fishes. Its descriptions are generally exact, its statements correct, its plates accurate and its judgments trustworthy. But with all this it is very unequal. Many of the species are treated very lightly by Cuvier; many of the descriptions of Valenciennes are very mechanical, as though the author had grown weary of the endless process, 'a failing commonly observed among zoologists when attention to descriptive details becomes to them a tedious task.' As Günther observes, the number of nominal species is almost doubled because the authors neglected to give proper attention to the changes in different species due to age and sex.

After the death of Valenciennes (1848) Dr. Auguste Duméril (son of Constant Duméril) began a continuation of this work, publishing two volumes (1865–1870) covering sharks, ganoids and other fishes not treated by Cuvier and Valenciennes. The death of Duméril left the great catalogue still incomplete. Duméril's work is useful and carefully done, but his excessive trust in slight differences has filled his book with nominal species. Thus among the ganoid fishes he recognizes 135 species, the actual number being not far from 40.

We may anticipate the sequence of time by here referring to the remaining attempts at a record of all the fishes in the world. Dr. Albert C. L. G. Günther, a German naturalist resident in London, and long the Keeper of the British Museum, published in eight volumes the 'Catalogue of the Fishes of the British Museum,' from 1859 to 1870. In this monumental work, the one work most essential to all systematic study of fishes, 6,843 species are described and 1,682 doubtful species are mentioned. The book is a tremendous example of patient industry. Its great merits are at once apparent, and those of us engaged in the same line of study may pass by its faults with the same leniency which we may hope that posterity may bestow on ours.

The publication of this work gave a remarkable stimulus to the study of fishes. The number of known species had been raised from 9,000 to about 12,000, and some hundreds of species even accepted by the conservatism of Günther have been erased from the system.

A new edition of this work has been long in contemplation, and in 1898 the first volume of it, covering the percoid fishes, was published by Dr. George Albert Boulenger. This volume is one of the most satisfactory in the history of ichthyology. It is based on ample material. Its accepted species have been subject to thorough criticism and in its classification every use has been made of the teachings of morphology and especially of osteology. Its classification is distinctly modern, and with the writings of the contemporary ichthyologists of Europe and America, it is fully representative of the scientific era ushered in by the researches of Darwin. The chief criticism which one may apply to this work concerns most of the publications of the British Museum. It is the frequent assumption that those species not found in the greatest museum of the world do not really exist at all. There are still many forms of life, very many, outside the series gathered in any or all collections.

We may now turn from the universal catalogues to the work on special groups, on local faunas or on particular branches of the subject of ichthyology. These lines of study were made possible by the work of Cuvier and Valenciennes and especially by that of Dr. Günther.

Before taking up the students of faunal groups, we may, out of chronological order, consider the researches of three great taxonomists, who have greatly contributed to the modern system of the classification of fishes.

Louis Agassiz (born in western Switzerland in 1807; died at Cambridge, Massachusetts, in 1873) was a man of wonderful insight in zoological matters and possessed varied range of scientific information, scarcely excelled in any age—intellectually a lineal descendant of Aristotle. His first work on fishes was the large folio on the fishes collected by Jean Baptiste Spix in Brazil, published at Munich in 1827. After his establishment in America in 1846, at which time he became a professor in Harvard University, Agassiz published a number of illuminating papers on the fresh-water fishes of North America. He was the first to recognize the necessity of the modern idea of genera among fishes, and almost all of the groups so designated by him are retained by later writers. He was also the first to investigate the structure of the singular viviparous surf-fishes of California, the names *Embiotoca* and *Holconoti* applied to these fishes being chosen by him.

His earlier work, 'Recherches sur les Poissons des Eaux Douces,' published in Europe, gave a great impetus to our knowledge of the anatomy and especially of the embryology of the fresh-water fishes. Most important of all his zoological publications was the 'Recherches sur les Poissons Fossiles,' published at Neufchâtel from 1833 to 1843. This work laid the foundation of the systematic study of the extinct groups of fishes. The relations of sharks were first appreciated by Agassiz, and the first segregation of the ganoids was due to him. Although he included in this group many forms not truly related either to the ganoids or even to the extinct arthrognaths, yet the definition of this order marked a great step in advance.

The great, genial, hopeful personality of Agassiz and his remarkable skill as a teacher made him the 'best friend that ever student had' and gave him a large following as a teacher. Among his pupils in ichthyology were Charles Girard, Frederick Ward Putnam, Alexander Agassiz, Samuel Garman, Samuel H. Scudder and the present writer.

Johannes Müller (1808–1858), of Berlin, was one of the greatest of comparative anatomists. In his revision of Cuvier's 'System of Classification' he corrected many errors in grouping, and laid founda-

tions which later writers have not altered or removed. Especially important is his classical work, 'Ueber den Bau und die Grenzen der Ganoiden.' In this he showed the real fundamental characters of that group of archaic fishes, and took from it the most heterogeneous of the elements left in it by Agassiz. To Müller we also owe the first proper definition of the Leptocardii and the Cyclostomi, and, in association with Dr. J. Henle, Müller has given us one of the best general accounts of the sharks ('Systematische Beschriebungen der Plagiostomen'). To Müller we owe an accession of knowledge in regard to the duct of the air-bladder, and the groups called Dipneusti (Dipnoi), Pharyngognathi and Anacanthini were first defined by him, although now usually restricted within narrower limits than those assigned by him.

In his work on the Devonian fishes, the great British comparative anatomist, Thomas Henry Huxley, first distinguished the group of Crossopterygians, and separated it from the Ganoids and Dipnoans.

Theodore Nicholas Gill is the keenest interpreter of taxonomic facts yet known in the history of ichthyology. He is the author of an immense number of papers, the first bearing date of 1858, touching almost every group and almost every phase of relation among fishes. His numerous suggestions as to classification have been usually accepted in time by other authors, and no one has had a clearer perception than he of the necessity of orderly methods in nomenclature. Among the orders first defined by Gill are the Eventognathi, the Haplomi, the Xenomi and the group called Teleocephali, which included all the bony fishes except those which showed peculiar eccentricities or modifications. Dr. Gill's greatest excellence has been shown as a scientific critic. Incisive, candid and friendly, there is scarcely a scientific man in America who is not directly indebted to him for critical aid of the highest importance. The present writer cannot too strongly express his own obligations to this great teacher, his master in fish taxonomy, as Agassiz was in fish ecology. Dr. Gill's work is not centered in any single great treatise, but is diffused through a very large number of brief papers and catalogues, those from 1861 to 1865 mostly published by the Academy of Natural Sciences in Philadelphia, those of recent date by the United States National Museum. For many years Dr. Gill has been identified with the work of the Smithsonian Institution at Washington.

Closely associated with Dr. Gill was Dr. Edward Drinker Cope, of Philadelphia, a tireless worker in almost every field of zoology, and a large contributor to the broader fields of ichthyological taxonomy as well as to various branches of descriptive zoology. Cope was one of the first to insist on the close relation of the true ganoids with the teleost fishes, the nearest related group of which he defined as Isospondyli. In breadth of vision and keenness of insight, Cope ranked with the first of taxonomic writers. Always bold and original, he was not at all times accurate in details, and to the final result in classification his contribution has been less than that of Dr. Gill. Professor Cope also wrote largely on American fresh-water fishes, a large percentage of the Cyprinidæ and Percidæ of the eastern United States having been discovered by him, as well as much of the Rocky Mountain fauna. In later years his attention was absorbed by the fossil forms, and most of the species of the Cretaceous rocks and the Eocene shales of Wyoming were made known through his ceaseless activity.

The enumeration of other workers in the great field of ichthyology must assume something of the form of a catalogue. Part of the impulse received from the great

works of Cuvier and Valenciennes and of Günther was spent in connection with voyages of travel. In 1824, Quoy and Gaimard published in Paris the great folio work on the fishes collected by the corvettes *L'Uranie* and *La Physicienne* in Freycinet's voyage around the world. In 1834, the same authors published the fishes collected in Dumont D'Urville's voyage of the *Astrolabe*. In 1826 Lesson published the fishes voyage around the world. In 1834, the great works lie at the foundation of our knowledge of the fishes of Polynesia. In 1839, Eydoux and Gervais published the fishes of the voyage of *La Favorite*. In 1853, also in Paris, Homborn and Jacquinot gave an account of the fishes taken in Dumont D'Urville's expedition toward the South Pole. In England, Sir John Richardson, a wise and careful naturalist, wrote of the fishes collected by the *Sulphur* (1845), the *Erebus* and *Terror* (1846) and the *Herald*. Lay and Bennett recorded the species taken by Beechey's voyage on the *Blossom*. More important than any of these is the account of the species taken by Charles Darwin on the voyage of the *Beagle*, prepared by the conscientious hand of Rev. Leonard Jenyns. Still more important and far ranging is the voyage of the *Challenger*, including the first important work in the deep seas, the stately volume and parts of other volumes on fishes being the work of Dr. Günther. Other deep-sea work of equal importance has been accomplished in the Atlantic and the Pacific by the U. S. Fish Commission steamer *Albatross*. Its results in Central America, Alaska and Japan, as well as off both coasts of the United States, have been made known in different memoirs by Goode and Bean, Garman, Gilbert, Gill, Jordan, Cramer and others. The deep-sea fish collections of the *Fish Hawk* and the *Blake* have been studied by Goode and Bean and Garman.

The deep-sea work of other countries may be briefly noticed. The French vessels, *Travailleur* and *Talisman*, have made collections chiefly in the Mediterranean and along the coast of Africa, the results having been made known by Leon Vaillant. The *Hirondelle* about the Azores and elsewhere has furnished material for Professor Robert Collett, of the University of Christiania. Dr. Decio Vinciguerra, of Rome, has reported on the collections of the *Violante*, a vessel belonging to the Prince of Monaco. Dr. A. Alcock, of Calcutta, has had charge of the most valuable deep-sea work of the *Investigator* in the Indian seas. Dr. James Douglas Ogilby and Dr. Edgar R. White, Sydney, N. S. W., have described the collections of the *Thetis*, made on the shores of New South Wales.

From Austria the voyage of the frigate *Novara* has yielded large material which has been described by Dr. Rudolph Kner. The cream of many voyages of many Danish vessels has been gathered in the 'Spolia Atlantica' and other truly classical papers of Christian Frederik Lütken, of the University of Copenhagen, one of the great naturalists of our times.

F. H. von Kittlitz has written on the fishes seen by him in the northern Pacific, and earlier and more important we may mention the many ichthyological notes found in the travel records of Alexander von Humboldt in Mexico and South America.

The local faunal work in various nations has been very extensive. In Great Britain we may note Parnell's 'Natural History of the Fishes of the Firth of Forth,' published in Edinburgh in 1838, William Yarrell's 'History of British Fishes' (1859), the earlier histories of British fishes by Edward Donovan and by William Turton, and the works of J. Couch (1862) and Dr. Francis Day (1888), which possess similar titles. The work of Day, with its excellent plates,

will long be the standard account of the relatively scant fish fauna of the British Islands. H. G. Seelye has also a useful 'Synopsis of the Fresh-water Fishes of Europe.'

We may here notice without praise the extensive work of William Swainson (1839). W. Thompson has written of the fishes of Ireland, and Rev. Richard T. Lowe and J. Y. Johnson have done most excellent work on the fishes of Madeira. F. McCoy, better known for work on fossil fishes, may be mentioned here.

The fish fauna of Scandinavia has been described more or less fully by Kröyer (1840), Nilsson (1855), Fries and Ekström (1836), Collett, Lilljeborg and F. A. Smitt, besides special papers by other writers, notably Reinhardt, L. Esmarck, Japhetus Steenstrup, Lütken and A. W. Malm. Reinhardt, Kröyer, Lütken and A. J. Malmgren have written of the Arctic fishes of Greenland and Spitzbergen.

In Russia, Nordmann has described the fishes of the Black Sea ('Ichthyologie Pontique,' Paris, 1840) and Eichwald those of the Caspian. More recently, S. Herzenstein, Warpachowsky, K. Kessler, B. N. Dybowsky, Kamensky and others have written of the rich fauna of Siberia, the Caucasus and the scarcely known Sea of Okhotsk. Stephan Basilevsky has written rather unskillfully of the fishes of northern China. A. Kowalevsky has contributed very much to our knowledge of anatomy.

In Germany and Austria the chief local works have been those of Heckel and Kner on the fresh-water fishes of Austria (1858), and those of C. Th. von Siebold on the fresh-water fishes of Central Europe (1863). German ichthyologists have usually extended their view to foreign regions where their characteristic thoroughness and accuracy has made their work illuminating. The two memoirs of Edouard Rüppell on the fishes of the Red Sea and the neighboring parts of Africa, 'Atlas zu der Reise im Nördlichen Afrika,' 1828, and 'Neue Wirbelthiere,' 1837, rank with the very best of descriptive work. Günther's finely illustrated 'Fische der Südsee,' published in Hamburg, may be regarded as German work. Other papers are those of Dr. Wilhelm Peters on Asiatic fishes, the most important being on the fishes of Mozambique. J. J. Heckel, Rudolph Kner and Franz Steindachner, successively curators of the Museum of Vienna, have written largely on fishes. The papers of Steindachner cover almost every part of the earth and are absolutely essential to any serious systematic study of fishes. No naturalist of any land has surpassed Steindachner in industry or accuracy and his work has the advantage of the best illustrations of fishes made by any artist, the noted Edouard Konopicky. Other German writers are J. J. Kaup, who has worked in numerous fields, but as a whole with little skill, Dr. S. B. Klunzinger, who has given excellent accounts of the fishes of the Red Sea, and Dr. Franz Hilgendorf, of the University of Berlin, whose papers on the fishes of Japan and other regions have shown a high grade of taxonomic insight. Other writers of earlier date are Johann Marcusen, who studied the Mormyri, W. von Repp, who wrote on the fishes of the Lake of Constance, and J. F. Brandt.

In Italy, Charles Lucien Bonaparte, Prince of Canino, has published an elaborate 'Fauna Italica' (1838), and in numerous minor papers has taken a large part in the development of ichthyology. Many of the accepted names of the large groups (as Elasmobranchii, Heterosomata, etc.) were first suggested by Bonaparte. The work of Rafinesque has been already noticed. O. G. Costa published (about 1850) a 'Fauna of Naples.' In recent times G. Canestrini, Decio Vinciguerra, Enrico Hillyer Giglioli, Luigi Döderlein and others

have added largely to our knowledge of Italian fishes, while Carlo F. Emery, F. de Filippi, Luigi Facciola and others have studied the larval growth of different species. Camillo Ranzani, G. G. Bionconi, G. D. Nardo and others have contributed to different fields of ichthyology.

Nicolas Apostolides and, still later, Horace A. Hoffman and the present writer have written on the fishes of Greece.

In France, the fresh-water fishes are the subject of an important work by Emile Blanchard (1866), and Emile Moreau has given us a convenient fauna of France. Leon Vaillant has written on various groups of fishes, his monograph of the American darters (Etheostominæ) being a masterpiece so far as the results of the study of relatively scanty material would permit. The 'Mission Scientifique au Mexique,' by Vaillant and F. Bocourt, is one of the most valuable contributions to our knowledge of the fishes of that region. Dr. H. E. Sauvage, of Boulogne-sur-Mer, has also written largely on the fishes of Asia, Africa and other regions.

Important among these are the 'Poissons de Madagascar,' and a monograph of the sticklebacks. Alexander Thominot and Jacques Pellegrin have also written, in the Museum of the Jardin des Plantes, on different groups of fishes. Earlier writers were Alphonse Guichenot, L. Brissot de Barneville, H. Hollard, an able anatomist, and Bibron.

In Spain and Portugal, the chief work of local authors is that of J. V. B. Bocage and F. de Brito Capello on the fish of Portugal. So far as Spain is concerned, the chief memoir is Steindachner's account of his travels in Spain and Portugal. The principal studies of the Balkan region have also been made by Steindachner.

In Holland, the chief great works have been those of Schlegel and Pieter van Bleeker. Professor Schlegel, of the University of Leyden, described the fishes collected about Nagasaki by Ph. Fr. de Siebold and Bürger. His work forms a large folio illustrated by colored plates, the 'Fauna Japonica Poissons,' published in Leyden from 1844 to 1850. Schlegel's work in every field is characterized by scrupulous care and healthful conservatism, and the 'Fauna Japonica' is a most useful monument to his rare powers of discrimination.

Pieter von Bleeker (1819–1878), a surgeon in the Dutch West Indies, is the most voluminous writer in ichthyology. He began his work in Java without previous training and in a very rich field where almost everything was new. With many mistakes at first he rose to the front by sheer force of industry and patience, and his later work, while showing much of the 'personal equation,' is still thoroughly admirable. At his death he was engaged in the publication of a magnificent folio work, 'Atlas Ichthyologique des Indes Orientales Neerlandaises,' illustrated by colored plates. This work remains about two thirds completed. The writings of Dr. Bleeker constitute the chief source of our knowledge of the fauna of the East Indies.

Dr. Van Lidth de Jeude, of the University of Leyden, is the author of a few descriptive papers on fishes.

To Belgium we may assign part at least of the work of the eminent Belgian naturalist, George Albert Boulenger, now long connected with the British Museum. His various valuable papers on the fishes of the Congo are published under the auspices of the 'Congo Free State,' itself largely a creation of the government of Belgium. To Belgium also we may ascribe the work of Louis Dollo on the morphology of fishes, and on the deep-sea fishes obtained by the 'Expedition Antarctique Belge.'

The fish fauna of Cuba has been the life-long study of Dr. Felipe Poey y Aloy (1799–1891), a pupil of Cuvier, for a half cen-

tury or more the honored professor of zoology in the University of Havana. Of his many useful papers, the most extensive are his 'Memorias sobre la Historia Natural de la Isla de Cuba,' followed by a 'Repertorio' and an 'Enumeratio' on the same subject. Poey devoted himself solely to the rich fish fauna of his native island, in which region he was justly recognized as a ripe scholar and a broad-minded gentleman. A favorite expression of his was 'Comme naturaliste, je ne suis pas espagnol: je suis cosmopolite.' Before Poey, Guichenot, of Paris, had written on the fishes collected in Cuba by Ramon de la Sagra. His account was published in Sagra's 'Historia de Cuba,' and later Philip H. Gosse (1810–1888) wrote on the fishes of Jamaica. Much earlier, Robert Hermann Schomburgh (1804–1865) wrote on the fishes of British Guiana. Other papers on the Caribbean fishes were contributed by Johannes Müller and F. H. Troschel, and by Richard Hill and J. Hancock.

Besides the work in South America of Marcgrave, Agassiz, Reinhardt, Lütken, Steindachner, Jenyns, Boulenger and others already named, we may note the local studies of Dr. Carlos Berg in Argentina, Dr. R. A. Philippi in Chile, and special records of Humboldt, Garman, J. F. Abbott and others in recent times. Carl H. Eigenmann and also Jordan and Eigenmann have studied the great collections made in Brazil by Agassiz. Steindachner has described the collections of Johann Natterer, and Gilbert those made by Dr. John C. Branner. The most recent extensive studies of the myriads of Brazilian river fishes are those of Dr. Eigenmann. Earlier than any of these Francis de Castelnau (1855) described many Brazilian fishes and afterwards numerous fishes of Australia. Guichenot, of Paris, contributed a chapter on fishes to Claude Gay's 'History of Chile,' and J. J. von Tschudi, of St. Gallen, published an elaborate but uncritical 'Fauna Peruana' with colored plates of Peruvian fishes.

In New Zealand, F. W. Hutton and J. Hector have published a valuable work on the fishes of New Zealand, to which Dr. Gill added valuable critical notes in a study of 'Antipodal Faunas.' Later writers have given us a good knowledge of the fishes of Australia. Notable among them are W. Macleay, James Douglas Ogilby and Edgar R. Waite. Clarke has also written on 'Fishes of New Zealand.'

The most valuable work on the fishes of Hindustan is the elaborate treatise on the 'Fishes of India' by Surgeon Francis Day. In this all the species are figured, the groups being arranged as in Günther's catalogue, a sequence which few non-British naturalists seem inclined to follow. Cantor's 'Malayan Fishes' is a memoir of high merit, as is also McClelland's work on the fishes of the Ganges, and we may here refer to Andrew Smith's papers on the fishes of the Cape of Good Hope and to R. I. Playfair and A. Günther's 'Fishes of Zanzibar.' T. C. Jerdon, John Edward Gray, E. Tyrwhitt Bennett, J. Bennett and others have also written on the fishes of India.

In Japan, following the scattering papers of Thunberg, Tilesius and Houttuyn and the monumental work of Schlegel, numerous species have been recorded by James Carson Brevoort, Günther, Gill, Edouard Nyström, Hilgendorf and others. About 1884 Steindachner and Döderlein published the valuable 'Fische Japans,' based on the collections made about Tokyo by Dr. Döderlein. In 1881, Motokichi Namiye, then as now Assistant Curator in the Imperial University, published the first list of Japanese fishes by a native author. In 1900 Dr. Chiyomatsu Ishikawa, in a paper on the 'Fishes of Lake Biwa,' was the first Japanese author to venture to name a new species of fish (*Pseudogobio zezera*). This

reticence was due not wholly to lack of self-confidence, but rather to the scattered condition of the literature of Japanese ichthyology. For this reason no Japanese author has ever felt sure that any given undetermined species was really new. Other Japanese ichthyologists of promise are Dr. Kamakichi Kishinouye, Dr. Shinnosuke Matsubara and Keinosuke Otaki, and we may look for others among the pupils of Dr. Kakichi Mitsukuri, the distinguished Professor of Zoology in the Imperial University.

The most recent, as well as the most extensive, studies of the fishes of Japan were made in 1900 by the present writer and his associate, John Otterbein Snyder.

The scanty pre-Cuvieran work on the fishes of North America has been already noticed. Contemporary with the early work of Cuvier is the worthy attempt of Professor Samuel Latham Mitchell (1764–1831) to record in systematic fashion the fishes of New York. Soon after followed the admirable work of Charles Alexander Le Sueur (1780–1840), artist and naturalist, who was the first to study the fishes of the Great Lakes and the basin of the Ohio. Le Sueur's engravings of fishes, in the early publications of the Academy of Natural Sciences in Philadelphia, are still among the most satisfactory representations of the species to which they refer. Constantine Samuel Rafinesque (1784–1842), the third of this remarkable but very dissimilar trio, published numerous papers descriptive of the species he had seen or heard of in his various botanical rambles. This culminated in his elaborate but untrustworthy 'Ichthyologia Ohiensis.' The fishes of Ohio received later a far more conscientious though less brilliant treatment at the hands of Dr. Jared Potter Kirtland (1793–1877), an eminent physician of Cleveland, Ohio. In 1842 the amiable and scholarly James Ellsworth Dekay (1799–1851) published his detailed report on the 'New York fauna,' and a little earlier (1836) in the 'Fauna Boreali-Americana' Sir John Richardson (1787–1865) gave a most valuable and accurate account of the fishes of the Great Lakes and Canada. Almost simultaneously, Rev. Zadock Thompson (1796–1856) gave a catalogue of the fishes of Vermont, and David Humphreys Storer (1804–1891) began his work on the fishes of Massachusetts, finally expanded into a 'Synopsis of the Fishes of North America' (1846) and a 'History of the Fishes of Massachusetts' (1867). Dr. John Edwards Holbrook (1794–1871), of Charleston, published (1860) his invaluable record of the fishes of South Carolina, the promise of still more important work, which was destroyed by the outbreak of the Civil War. The monograph on Lake Superior (1850) and other publications of Louis Agassiz (1807–1873) have been already noticed. One of the first of Agassiz's students was Charles Girard (1822–1895), who came with him from Switzerland, and, in association with Spencer Fullerton Baird (1823–1887), described the fishes from the United States Pacific Railway Surveys (1858) and the United States and Mexican Boundary Surveys (1859). Professor Baird, primarily an ornithologist, became occupied with executive matters, leaving Girard to finish these studies of the fishes. A large part of the work on fishes published by the United States National Museum and the United States Fish Commission has been made possible through the direct help and inspiration of Professor Baird. Among those engaged in this work, James M. Milner, Hugh M. Smith and Marshall Macdonald may be noted.

Most eminent, however, among the students and assistants of Professor Baird was his successor, George Brown Goode (1851–1899), one of the most accomplished of American naturalists, whose greatest

work, 'Oceanic Ichthyology,' published in collaboration with his associate of many years, Dr. Tarleton Hoffman Bean, was barely finished at the time of his death. The work of Theodore Nicholas Gill and Edward Drinker Cope has been already noticed.

Other faunal writers of more or less prominence were William Dandridge Peck (1763–1822) in New Hampshire, George Suckley (1830–1869) in Oregon, James William Milner (1841–1880) in the Great Lake Region, Samuel Stehman Holdeman (1812–1880) in Pennsylvania, William O. Ayres (1817–1891) in Connecticut and California, Dr. John G. Cooper, Dr. William P. Gibbons and Dr. William N. Lockington in California. Philo Romayne Hoy (1816–1893) studied the fishes of Wisconsin, Charles Conrad Abbott those of New Jersey, Silas Stearns (1859–1888) those of Florida, and Stephen Alfred Forbes those of Illinois.

Samuel Garman, at Harvard University, a student of Agassiz, is the author of numerous valuable papers, the most notable being on the sharks and on the deep-sea collections of the *Albatross* in the Galapagos region, the last illustrated by most excellent plates.

The present writer began a 'Systematic Catalogue of the Fishes of North America' in 1875, in association with his gifted friend, Herbert Edson Copeland (1849–1876), whose sudden death, after a few excellent pieces of work, cut short the undertaking. Later, Charles Henry Gilbert (1860–), a student of Professor Copeland, took up the work and in 1883 a 'Synopsis of the Fishes of North America' was completed by Jordan and Gilbert. Dr. Gilbert has since been engaged in studies of the fishes of Panama, Alaska and other regions, and the second and enlarged edition of the 'Synopsis' was completed in 1898 as the 'Fishes of North and Middle America,' in collaboration with another of the writer's students, Dr. Barton Warren Evermann. A 'Monographic Review of the Fishes of Puerto Rico' was later (1900) completed by Dr. Evermann, together with numerous minor works. Other naturalists whom the writer may be proud to claim as students are Charles Leslie McKay (1854–1883), drowned in Bristol Bay, Alaska, while engaged in explorations, and Charles Henry Bollman, stricken with fever in the Okefenokee Swamps in Georgia. Still others were Dr. Carl H. Eigenmann, the indefatigable investigator of Brazilian fishes and of the blind fishes of the caves; Dr. Oliver Peebles Jenkins, first explorer of the fishes of Hawaii; Dr. Alembert Winthrop Brayton, explorer of the streams of the Great Smoky Mountains; Dr. Seth Eugene Meek, explorer of Mexico; John Otterbein Snyder, explorer of Mexico, Japan and Hawaii; Edwin Chapin Starks, explorer of Puget Sound and Panama and investigator of fish osteology. Still other naturalists of the coming generation, students of the present writer and of his lifelong associate, Professor Gilbert, have contributed in various degrees to the present fabric of American ichthyology. Among them are Mrs. Rosa Smith Eigenmann, Dr. Joseph Swain, Wilbur Wilson Thoburn, Frank Cramer, Alvin Seale, Albert Jefferson Woolman, Philip H. Kirsch, Cloudsley Rutter, Robert Edward Snodgrass, James Francis Abbott, Arthur W. Greeley, Edmund Heller, Henry Weed Fowler, and Richard Crittenden McGregor.

Other facts and conclusions of importance have been contributed by various persons with whom ichthyology has been an incident rather than a matter of central importance.

As students of the extinct fishes, following the monumental work of Louis Agassiz, some of the notable names are those of Pander, Asmuss, Heckel, Hugh Miller

and R. H. Traquair. An indispensable 'Handbuch der Palaeontologie' is that of Karl A. Zittel (1890), in which the knowledge of fossil fish is brought up to a recent date. The most valuable general work is the 'Catalogue of the Fossil Fishes in the British Museum,' in four volumes, by Dr. Arthur Smith Woodward, a most worthy companion of Günther's 'Catalogue' of the living fishes, and still more modern in the taxonomy and views of relationships. Important contributions are those of Huxley, F. McCoy, van den Marck, de Koninck, Davis, Nicholson, Charlesworth, Sir Philip Egerton, Rictet, Kner, von Meyer, Hasse, Thiollière, Jaekel, Rohon, Sauvage, Stolicza, Lawley, Molin, Gibbes, Probst, Karpinsky, Kipryanoff and many others.

In America, Dr. John Strong Newberry has studied the fossil fishes of Ohio. Professor Edward W. Claypole has worked largely in the same region. Edward Drinker Cope and Dr. Joseph Leidy have added to our knowledge of the Eocene and Cretaceous fishes of the Rocky Mountains. Numerous recent papers of great value have been published by Dr. Bashford Dean, of Columbia University, and Dr. Charles R. Eastman, of Harvard. Other important records are due to Orestes St. John, A. H. Worthen, Charles D. Walcott and the Redfields, father and son.

Still more difficult of enumeration is the long list of those who have studied the anatomy of fishes, usually in connection with the comparative anatomy or development of other animals. Preeminent among these are Karl Ernst von Baer, Cuvier, Goffrey St. Hilaire, Louis Agassiz, Johannes Müller, Carl Vogt, Carl Gegenbaur, Meckel, William Kitchen Parker, Francis M. Balfour, Thomas Henry Huxley, H. Rathke, Richard Owen, Kowalevsky, H. Stannius, Joseph Hyrtl, Gill, Boulenger and Bashford Dean. Other names of high authority are those of Wilhelm His, Köliker, Bakker, Rosenthal, Gottsche, Miklucho, Macleay, Weber, Hasse, Retzius, Owsjannikow, H. Müller, Stieda, Marcusen and Ryder.

Besides all this, there has risen, especially in the United States, Great Britain, Norway, Canada and Australia, a vast literature of commercial fisheries, fish culture and angling, the chief workers in which fields we may not here enumerate even by name.

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*JOINT MEETINGS OF THE GEOLOGICAL SOCIETY OF AMERICA, SECTION E, AND THE NATIONAL GEOGRAPHIC SOCIETY.**

The Geology of the Pittsburgh District: I. C. White.

The Appalachian coal field begins near the northern line of Pennsylvania, and extends in a canoe-shaped trough 900 miles southwestward, ending in western Alabama. Pittsburgh is situated near the center of the northern end of this great basin, and has, therefore, easy access to all of the coal formations.

To one of these beds, the great Pittsburgh seam, which overlooks the city from an elevation of 350 feet, and extends up the Monongahela for 200 miles, the industrial supremacy of the region is largely due.

Several years ago the gifted Blaine predicted that the Pittsburgh district would in time become the manufacturing center of the world because of its command of cheap fuel. This prophecy has become a reality within less than a decade of its utterance.

The Monongahela formation, of which the Pittsburgh coal is the basal member, caps all the hills around the city and stretches away to the south up the river which gave the beds a name, to be in turn covered up by the Dunkard formation at

* Pittsburgh, Pa., July 1 to 3, 1902.

the summit of the Carboniferous column and probably of Permian age. The city itself is located mostly on the Conamaugh formation or the old Barren Series of Rodgers, the central red beds of which crop along all the railroads which enter the city and give no end of trouble from landslides, slips and caves. These red beds enclose one of the most interesting deposits of the entire Carboniferous column, viz., the Ames or Crinoidal limestone. It marks the end of marine life in the Carboniferous waters of the Appalachian field, and is a most important 'key' rock. Coming as it does 300 feet below the Pittsburgh coal bed, and at an equal interval above the Upper Freeport seam, it has been traced from central West Virginia around through western Pennsylvania, across Ohio, and back into southern West Virginia near Huntington.

Within easy access from Pittsburgh the geologist may see all of the Carboniferous, and on the crest of the great Chestnut Ridge arch above Connellsville get a peep deep down into the Devonian.

This, however, has been given in the diagram before you, which represents the rocks under Pittsburgh as revealed in the deepest oil boring ever made in America, and, with one exception, the deepest in the world. This record we owe to the intelligent interest in pure science of Mr. W. J. Young, of Pittsburgh, now at the head of the great producing interests of the Standard Oil Co. At an expense of many thousands of dollars Mr. Young drilled this well near West Elizabeth, Pa., to a depth of 5,575 feet, and gave to Professor Hallock, of Columbia University, the opportunity to make his important contributions to earth temperatures. This is but one of numerous examples of encouragement to pure science given by the officers and agents of that much-abused organization.

But interesting as are the stratified rocks of the remote past in the Pittsburgh region, the surface deposits tell for many a still more attractive story. The clays, silts, sands, gravels and cobbles which rest upon the ancient river bottoms, and mantle up the slopes to 300 feet above the present streams, unfold a most interesting history. They reveal a river during Tertiary time flowing with its bed immediately under the site of the Carnegie Institute, 200 feet above the present streams, descending with gentle fall (only one third the rate of the present rivers), and at Beaver, instead of turning southward down the Ohio, keeping northward and joining the St. Lawrence system in the region of Lake Erie.

Then in Quaternary time, this northward-flowing river was met by a great mass of southward-moving ice and other glacial débris which effectually impounded the Allegheny and Monongahela drainage, and caused their waters to intermingle across the East Liberty valley, and finally to cut a new pathway to the sea along what is now the Ohio River. This great inland lake is marked by a series of deposits of clay, sand, boulders and other transported materials upon all except steep surfaces up to a little more than 1,000 feet above tide over the entire basin of the two rivers. Mr. Campbell, of the U. S. Geological Survey, has recognized the character of these upland deposits as having been made in a lake-like body of water, but has erroneously referred them to a local ice dam. The one great dam which we know existed just north from Beaver will explain all the phenomena.

The Lower Carboniferous of the Appalachian Basin: J. J. STEVENSON. (Read by title.)

In this paper a description is given of the several divisions of the Lower Car-

boniferous as they exist in the Appalachian basin; the effort is made to determine the boundary between Devonian and Carboniferous and to ascertain the changes in physical geography during the period.

A New Meteorite from Algoma, Kewaunee County, Wisconsin: William Herbert Hobbs.

The Algoma meteorite, which was plowed up near Algoma, Wis., in 1887, was recognized in March of the present year as a true meteorite. It is almost unique among meteorites because of its peculiar shape and surface markings. Whereas most meteorites are quite irregular in form, this meteorite is in the shape of a thin shield, or disk, with convex and concave sides. Contrary to common notions it is quite clear that this body, when it entered the atmosphere of the earth, presented its convex surface to the front, and was in part by the erosion of the air given its present form, and its convex surface was deeply eroded. From a central, smooth, elliptical area upon the front, radial and slightly spiral groovings proceed to the circumference of the meteorite. It seems clear that these groovings and ridges are the result of fusion and erosion by the compressed air, the dead-air area in front of the center preventing a similar grooving there.

Although not generally appreciated, it appears that there have been other disk-like meteorites, and from the principles of mechanics it is clear that they, like the Algoma meteorite, must have moved through the atmosphere with their broad side on.

The Algoma meteorite shows well the Widmanstätten figures produced by etching, and also numerous crystals of schreibersite.

The Meteorites of Northwestern Kansas. Oliver C. Farrington.

Of the thirteen meteorites known from Kansas, six have been found within an area 115 miles long by 85 miles broad in the northwestern part of the State. As these all resemble each other in outward appearance the question has been raised as to whether they belong to a single fall. In deciding the question the probable course of a meteor and the structure and composition of the meteorites should be discussed. It is shown that the probable course of the meteor would have been from southeast to northwest, and not from southwest to northeast as would be required if the meteorites belonged to a single fall. As regards structure and composition, three of the meteorites have been studied, while the other three have not. Results of studies of two of the latter, Long Island and Franklinville, are given and the Long Island meteorite shown to be, in several respects, remarkable. The conclusion is reached that two of the meteorites may belong to one fall but that the others are single individual falls.

The Mohokea Caldera on Hawaii: C. H. Hitchcock.

The eruptions from Mauna Loa upon the southwest side are different from those upon the northeast, chiefly in being of the explosive type. The new map of Hawaii develops the interesting facts of the existence of an immense depression analogous to a caldera a few miles back from Punuluu. It is of larger dimensions than the celebrated calderas of Mauna Loa and Kilauea.

Ellipsoidal Structure in the pre-Cambrian Basic and Intermediate Rocks of the Lake Superior Region: J. Morgan Clements.

The greenstones of pre-Cambrian age in the Lake Superior region have very com-

monly developed in them a structure which, since the masses separated by this structure are ellipsoidal, is designated 'ellipsoidal' structure. This structure was described and illustrated by means of lantern slides.

A review of the ideas held by various observers concerning the origin of this structure was given, and the conclusion was reached that the 'ellipsoidal' was an original structure due to the breaking up of a viscous lava while it was being extruded. The structure is of widespread occurrence, especially in the greenstones of the Lake Superior region.

The desirability of using the term 'ellipsoidal' instead of 'spheroidal' in referring to this structure is urged in view of the fact that it is an original structure, and that the bodies formed by this structure are ellipsoidal, whereas the spheroidal structure in the rocks is of secondary nature and is due to exfoliation caused by weathering.

Vermilion District of Minnesota: J. MORGAN CLEMENTS.

The Vermilion district occurs in northeastern Minnesota, extending from Vermilion lake, N. 70° E., to Gunflint lake on the international boundary. As described the district is about eighty miles long by ten miles wide. The area surveyed comprises nearly 1,000 square miles. The stratigraphic succession is as follows, given in descending order:

Pleistocene	Glacial drift.
(Unconformity).	
Keweenawan	Great Gabbro and Logan sills.
(Unconformity).	
Upper Huronian (Animikie series). Confined to eastern end of district	Upper slate formation. Gunflint formation (iron-bearing).
(Unconformity).	
Lower Huronian	Intrusives. Knife slates. Lower Huronian iron-bearing formation. Ogishke conglomerate.
(Unconformity).	
Archean (Vermilion series)	Intrusive granites, porphyries and greenstones. Soudan formation (iron-bearing). Ely greenstone.

The structure is complex. The Vermilion district is broadly a great complex synclinorium bounded on the north by the Archean granite, and on the south by the Huronian granite, Keweenawan gabbro, with the Upper Huronian slates coming in for a short distance. The ores are high-grade hematites, averaging 63 per cent. of iron and .05 per cent. of phosphorus, and they are found in structural basins. Since this district began to ship ore in 1884, it has sent out some 17,000,000 tons of ore, and the greater part of this came to Pittsburgh.

As regards the origin of the iron, it appears to come first from preexisting rocks, and then it is deposited to form the sedimentary iron-bearing formations. In the case of the Archean Soudan, the most economically important iron-bearing formation of this region, the iron comes from the Archean greenstone (basic and intermediate intrusives and volcanics). Later, after the folding, the iron is leached from the iron-bearing formation chiefly, and after being carried down by descending meteoric waters is precipitated as the oxide in places favorable for its accumulation, thus forming the ore deposits.

The Pacific Mountain System of British Columbia and Alaska: ARTHUR C. SPENCER.

The author brought together and attempted to interpret the existing descriptions of the physiography of the coastwise

mountains of British Columbia and Alaska. The term *Pacific Mountains,* which was used by Powell as a designation for the westernmost ranges of the United States, was extended to apply to the mountain ranges contiguous to the Pacific Ocean from Lower California to the Alaskan peninsula.

North of the United States the mountains are generally flat-topped and their uniform summits are considered to represent uplifted peneplains. Back of them the plateaus of the interior are of similar origin. Reasoning from the antecedent character of the rivers which head in the inland plateau, and cross the coastal mountain belts, and also from local merging of interior and mountain plateaus, it was shown that the peneplains of the various regions can be correlated. A great seaward-sloping surface of erosion was produced in Eocene time, and upon it the precursors of the present drainage systems were developed. Since the completion of this peneplain, all of the existing mountains have been formed, mainly by differential uplift attendant upon the general elevation of northwestern North America.

Development of the Southeastern Missouri Lowlands: C. F. Marbut. (Abstract read by W. M. Davis.)

The lowland region of southeastern Missouri consists of two broad belts of flat lowland with a discontinuous ridge between them. One of the lowland belts is an abandoned valley of the Mississippi river, the other is the valley of the Ohio. The Mississippi river has gained its existing valley by two successive changes, abandoning first about 200 miles of its original valley, and later about twenty more. It was led to abandon its valley because of a shorter and steeper course having been offered it by the Ohio. The Ohio drainage first captured some of the small tributaries of the Mississippi and later the Mississippi turned itself into these valleys in succession by sapping the ridge between. Since the capture of the Mississippi, several of the smaller rivers of the region have abandoned their older valleys.

Note.—The above papers were presented through the Geological Society of America, and for more complete accounts of the same see *Bulletin G. S. A.,* Vol. XIII., 1902.

The following papers were offered directly to Section E:

The International Geographic Congress of 1904 under the Auspices of the National Geographic Society: Gilbert H. Grosvenor. (Read by title.)

Possible Effects of the Glacial Period upon the Land Levels of Central Asia: G. Frederick Wright.

That northern and central Asia has experienced an extensive subsidence in recent geological time is proved by a variety of evidence:

1. Stadling reports gravel terraces containing fresh pieces of wood several miles back from the lower part of the Lena river, 650 feet above it. In some cases these terraces contain the bones of the mastodon and are resting upon solid ice.

2. On the south shore of the Black sea at Trebizond and Samsun, and upon the north shore around the Crimea, there are fresh gravels which are evidently beach deposits, hanging upon the sides of cliffs, indicating a recent subsidence of that whole region to the extent certainly of 750 feet.

3. In the Dariel pass, on the north side of the Caucasus mountains, a few miles above Vladikavkas, there are extensive recent water deposits, with the finer material at the bottom and the coarser material at the top, which could have accumulated only when the gradient of the incline was very

much less than it is now. These accumulations are sometimes more than 200 feet thick, and are beyond the reach of any glaciers which ever extended down the north side of the range. While these do not indicate a depression below the surface of the ocean, they do necessitate a depression to the south such as would change the relative level of the valley occupied by the upper part of the Terek river.

4. The existence of arctic seal (*Phoca annelate*) in Lake Baikal is best explained on the theory of a recent depression, permitting the sea to extend inwards to all the points now marked by that level. The lake is 1,561 feet above the sea, and fully 2,000 miles distant as the river runs. The presence of the seal in the lake is readily explained by this supposition of a recent subsidence of the region, but is not satisfactorily explained by any other theory. Reaching the enclosure while it was an arm of the sea, the seal would find a favorable habitat, and when, on re-elevation of the land, the basin became cut off from direct communication with the sea, the water would still be salt, and would grow fresh so gradually that the species could adjust itself to the slowly changing conditions and remain a permanent inhabitant. The same seal is also found in the Caspian sea, and was formerly found in the Aral sea.

5. The distribution of the loess around the base of the Alatau and other immense mountain masses of central Asia is such as to indicate a temporary water level from 2,500 to 3,000 feet higher than now. Whatever may have been the ultimate origin of this peculiar soil, its distribution in northern China, in Turkestan, about the base of Mount Ararat, at the southern base of the Caucasus mountains, and over the plains of southern Russia, is unaccountable except by the assistance of water action; while the occurrence of the bones of post-Pliocene animals and the remains of man underneath it, both in Russia and in Siberia, together with the small amount of erosion that has taken place in it, indicates that the change of level was approximately contemporaneous with the glacial period both in America and in northwestern Europe.

The result of observations in eastern Mongolia, Manchuria, Transbaikalia, and along the base of the Tian Shan range in Turkestan was to show that, during the glacial period, there was no extension of ice anywhere in Asia south of the sixtieth degree of latitude at all corresponding to that in America and in Europe; therefore, the weight of ice could not explain the depression of the Asiatic continent.

But the removal of 6,000,000 cubic miles of water from the ocean bed to form the glaciers of Europe and America, which would be equal to 24,000,000,000,000,000 tons, would naturally so disturb the balance of forces that a continental mass like Asia, with mountains rising from 25,000 to 30,000 feet above the sea, would sink down by its own weight.

Recent Geology of the Jordan Valley: G. FREDERICK WRIGHT.

West of the Jordan the descent from Jerusalem to Jericho is something more than 3,000 feet in about fifteen miles, and the underlying rock is all Cretaceous, the strata dipping to the east even more rapidly than the road descends. A fault of some 4,000 to 5,000 feet occurs along the Jordan valley, so that the abrupt wall which forms the western face of the mountains of Moab has at its base Nubian sandstone strata which underlie the Cretaceous, the Cretaceous rocks appearing near the summit, where the elevation is about 4,000 feet above the Dead sea, or nearly the same as that of Jerusalem and the surrounding hills of Judea.

Approximately the grand movements producing this fault may be fixed as beginning in the Middle Tertiary period, since Lower Tertiary rocks, consisting of nummulitic limestone, are found on Mounts Carmel, Ebal and Gerizim, and on some of the heights in the vicinity of Jerusalem and to the south of Hebron.

The extensive post-Tertiary deposits of silt extend as high as 750 feet above the Dead sea, showing that up to a recent time the water was 750 feet higher than now, producing a lake several times larger than the Dead sea, and extending southward about forty miles beyond the Dead sea, in which were deposited hundreds of feet of fine sediment where side streams came in, and one hundred feet or more over the entire valley. In the wady Zuweiya, where it enters the depression near the south end of the Dead sea, one can see the fine laminæ of this sediment as it has gradually accumulated to a depth of between 200 and 300 feet just below the 750-foot line, and where it has been exposed by subsequent erosion.

The Jordan valley throughout all its lower portion occupies a narrow gorge which it has cut out of this sedimentary deposit. The river is constantly undermining its banks, now on one side and now on another, leaving, pretty generally, perpendicular walls of the sedimentary deposits separated from the river by a flood-plain of varying width, averaging about a quarter of a mile. As a consequence the river is extremely muddy as it enters the Dead sea.

Notwithstanding the vigor of these erosive agencies only a relatively small portion of the sediment has been washed away, and the Dead sea is still unfilled, which is a witness to the recentness of its formation. The drainage basin of the Jordan valley is more than 10,000 square miles in extent; while the immediate valley itself is scarcely one fifteenth as large. All the wash of this large drainage area finally lodges in the valley.

If we estimate the rate of erosion in the drainage basin of the Jordan at one foot in 2,000 years, the age of the Jordan fault must be reckoned in tens of thousands of years, rather than in hundreds of thousands; thus confirming the shorter geological chronology of the physicists.

History of the Discoveries and Discussions Concerning the Glacial Terraces in the Upper Ohio and its Tributaries: G. Frederick Wright.

Submerged Valleys in Sandusky Bay: E. L. Moseley.

Tilting of the earth's crust is causing a depression of the land at the southwest extremity of Lake Erie as compared with the outlet at Buffalo. The effect of this is shown in the vicinity of Sandusky by the extension of the water over the low ground as evidenced by surveys, submerged stumps, slack water in the lower course of all the streams and submerged stalagmites in the caves of Put-in bay. It is also shown by the fact that from the mouth of each stream entering Sandusky bay a valley now filled with mud can be traced out through the bay. These valleys show a rise of the water of at least forty feet.

Some Geological Notes in Honduras, Central America: J. Francis Patch-Le Baron. (Read by title.)

The main geological features of Honduras are volcanic, but of a former age. These features are more pronounced on the Pacific slope, but there are at present no live volcanoes in the Republic.

The greater part of the stratified formations belong to the Permian. The characteristic country rock in the departments of

Olancho, Yoro and Mosquitia is a quartzose conglomerate, 1,000 feet in thickness. In the vicinity of Tegucigalpa, the characteristic section is composed of red and green marls nearly a thousand feet thick. These are capped with limestones, red conglomerates, sandstones and shales, very rich in gold and silver. The beds of non-fossiliferous limestones in Honduras are immense, and we find the old sea basins in many places 3,000 feet above present sea-level.

Granite and syenite occur on the coast west of Trujillo, and basalts and lavas are found all over the country in great abundance.

Geological classification is difficult in Honduras on account of the great mass of eruptive rocks which have been greatly metamorphosed.

The Great Canyon of the Euphrates River: ELLSWORTH HUNTINGTON.

Although the Euphrates river is known by name to every one certain parts of its upper course are still almost unexplored. One of the least known sections is where the river, after the junction of its two largest branches, flows over great rapids through the Taurus mountains in an immense canyon.

In 1883 the great German general von Moltke floated down this part of the stream on a raft of inflated sheepskins manned by Kurds, but the rapids are so formidable that for over sixty years no other Europeans visited the region. In the spring of 1901 Professor T. H. Norton, U. S. Consul at Harput, Turkey, and the writer made the same journey, using a raft of inflated sheepskins manned by Armenian fishermen. For the first hundred miles no great difficulties were met, although at one place the Kurds threatened the party with their guns, because the strangers floated past the place where a Kurdish lord had the right of ferriage. In another place a crowd of Turkish villagers stoned the raft because the Armenian fishermen had no fish to sell. In both cases the natives refrained from further violence out of respect for the fact that the travelers wore hats and so must be men of consequence.

Two small canyons were traversed, the second of which, nearly 2,000 feet deep, was the picturesque home of large herds of ibex. Below this is a holy mountain, with several shrines, at one of which rises an immense square altar of rough stone, all covered with the gore of the numerous goats and sheep which are here offered in sacrifice by both Christian Armenians and Mohammedan Turks.

The main canyon is cleft through the mountains to a depth of from 2,000 to 5,000 feet, and the contracted stream thunders over rapid after rapid between towering walls of frowning basalt or castellated buff limestone. In many ways it resembles the grand canyon of the Colorado, with its exceedingly swift current obstructed here and there by fans of detritus brought in from the sides, its steep walls of naked rocks and its raging rapids. In some places the main stream has cut its gorge so fast that the smaller tributaries could not keep pace with it, and so fall over the walls into the river in a series of cascades. All these facts and many others show that the Euphrates is very young geologically.

The real difficulties of the voyage began in the great canyon. At the first big rapid a whole day was spent in making a portage of two miles, involving a climb of 1,200 feet over an almost impassable road; in another place, while the raft was being let down past a rapid with ropes, a raft of logs floated by, on which were two almost nude Kurds, with tridents for paddles and

strings of dried gourds around their waists for preservers.

The difficulties became greater and greater as the party floated swiftly into the wilder parts of the canyon, where rapids were shot far larger than those where portages had been made a day or two earlier. The raftsmen's nerves were so completely unstrung one night that they dared neither shoot the rapids, nor climb the mountain side to get help from the Kurds in making a portage. Next day, the wildest of all the rapids was reached. The raftsmen dared not shoot it, and a portage was out of the question, so the Americans decided to shoot it alone, in spite of the entreaties of the servants, who fell on their knees, and, with tears in their eyes, begged the foreigners not to go to certain death. The raft shot into the rapids over a long smooth, tilting sheet of water; there was a wild exhilarating slide, and the great waves broke over the explorers, time and time again wetting them through to the skin; the raft whirled round and round. Soon the danger was passed, and the raft safely moored. The journey lasted seven days because of the numerous portages, although the actual time occupied in floating on the river was but thirty-seven hours.

The youthfulness of the deeper part of the canyon seems to be due to a recent revival of deformation, which has caused the streams to incise deep, steep-sided, V-shaped, young valleys in the bottoms of broad, U-shaped, older valleys.

Systematic Geography: W. M. Davis.

Observations of geographical matters by travelers and explorers are usually incomplete in one respect or another, largely because there is no maturely developed and generally accepted scheme of systematic geographical classifications, by which the relation of the whole of the subject to its parts is concisely indicated. The facts of inorganic environment on the one hand (physiography) and of environed organisms on the other (ontography), which constitute, when studied in their mutual relations, the subject matter of geography proper, can only be appreciated after careful analysis and arrangement. Geography may be given a regional aspect when the features of a single region are considered; but complete regional description implies a previous understanding of general systematic geography; for otherwise, regional facts cannot be recognized as examples of the large classes of facts in which they fall. Systematic geography is therefore a fundamental study. The author outlined the chief subdivisions of its two parts, physiography and ontography, and discussed the order in which the relations between them should be considered.

Some Topographic Features in the Southern Appalachians: J. A. Holmes.

The Petrographic Province of Neponset Valley, Boston, Massachusetts: F. Bascom. (Read by title.)

The Occurrence of Liquid Petroleum Hermetically Enclosed with Quartz Crystals, from Alabama: F. L. Stewart.

Restoration of Embolophorus dollovianus: E. C. Case. (Read by title.)

Synopsis of the Missourian and Permo-Carboniferous Fish Fauna of Kansas and Nebraska: C. R. Eastman and E. H. Barbour.

The majority of Upper Carboniferous fish remains from Nebraska are from the Atchison shales in the southeastern part of the State, and consist almost exclusively of Elasmobranchs. Some of these are intimately related to those of older horizons from the region east of the Mississippi, including even the Chester limestone, and a

lesser number are suggestive of a Permian aspect. Only a few species occur in the Permo-Carboniferous of Nebraska, and at least one of them is identical with a Permian species from the Red Beds of Texas. The Upper Coal Measure fish fauna of Kansas is slightly more varied than that of Nebraska, Dipnoans and Crossopterygians being represented besides Elasmobranchs. Altogether, more than twenty species of fish remains are known from this region.

Phylogeny of the Cestraciont Group of Sharks: C. R. EASTMAN.

The family of Cestraciont sharks has had a continuous existence since the Devonian, a range which is paralleled among fishes only by the *Ceratodus* group of Dipnoans. Some of the Devonian and Carboniferous forms (*Protodus, Campodus, Edestus, Helicoprion,* etc.) were remarkable for their great development of symphysial teeth, which became coiled without being shed, but none of these specialized genera are known to have survived the Paleozoic. This family probably gave rise to the Cochliodonts with inrolled crushing teeth in the Middle Paleozoic, and to the modern ray type during the Mesozoic. The existing Port Jackson shark is the sole survivor of the generalized Cestraciont stem, and special importance is attached to a study of its embryological phases.

On a Complete Skeleton of a New Cretacean Plesiosaur, Illustrated from Photographs from Mounted Skeletons: S. W. WILLISTON.

The Bacubirito Meteorite: H. A. WARD.

Bacubirito is a small but very old mining town situated on the Rio Sinaloa in latitude 26° and in west longitude 107°. The elevation above sea-level is some 2,000 feet. The meteorite is seven miles nearly due south from there, near the hamlet called Palmar de la Sepulveda. It was struck by the plow of Crescencio Aguilar in the summer of 1871. He soon uncovered enough of its bright surface to satisfy himself that he had found a silver mine! Its surrounding is now a cornfield, with a black vegetable soil of some two yards in thickness. In this soil we found the great meteorite deeply imbedded. Its surface was but a little below the surface of the ground.

The general form of the mass seen from the side was that of one ramus of a huge jaw. The surface was entirely covered with 'pittings,' very regular in size, and about two to three inches across, shallow, but with well-defined walls. There were no areas which showed the devastation of deep rust; a fact due both to the dryness of the soil and to the large alloy of nickel in the iron. On one side there was a deep crack, running horizontally through half the length of the mass. At one end this crack was too narrow to insert a knife blade, at the other end it was nearly three inches wide. Over the area the vegetable soil was from three to four feet deep, while below it was a porphyry rock, common in this part of the country, much broken up by natural cleavages and decomposed *in situ*.

Immediately around the meteorite we had dug much lower, leaving the great iron mass poised on a pillar or pedestal of the undisturbed rock. It needed little mechanical aid to make the mass turn over. Looking beneath it we found that its late bed was a clean depression crushed into the rock, with absolutely no soil between it and the mass which had lain above it.

The extreme measures of Bacubirito, for so our meteorite from the first has been called, are:

Length	13	feet	1	inch.
Width	6	"	2	"
Thickness	5	"	4	"

The form of the mass is extremely irregular, and though measures have been taken around the mass at many different points, its cubic contents cannot be calculated with more than an approximation to accuracy.

The five largest meteorites known to science to-day are:

Bemdego (Brazil)	5⅓	tons.
San Gregoria (Mexico)	11½	"
Chupaderos (Mexico)	15⅔	"
Anighito (Greenland)	50	"
Bacubirito (Mexico)	50	"

The first three are weights proven on scales: the last two are thus far simple estimates.

Whichever meteorite shall, after accurate calculation, prove to be the heavier, it will ever remain of interest that the two largest meteorites known to our earth have fallen on the North American continent—one far toward its northern end, the other toward its southern.

Paleontological Notes: (a) Notes on Gastropods, (b) Spirifer mucronatus and its Derivatives: A. W. Grabau. (Read by title.)

The following papers were read under the auspices of the National Geographical Society:

Scientific Results of the Recent Eruptions in the West Indies: R. T. Hill.

The Magnetic Disturbances during the Time of the Recent Volcanic Eruptions in Martinique: L. A. Bauer.

Atmospheric Phenomena in Connection with the Recent Eruptions in the West Indies: A. J. Henry. (Read by G. H. Grosvenor.)

F. P. Gulliver,
Secretary, Section E.

DR. J. G. COOPER.

News has been received of the death at Hayward, Alameda County, California, of Dr. James G. Cooper, at the age of seventy-two years, July 19, 1902. Dr. Cooper's services to science have been such (coupled with the singular omission of his name and his father's from the chief records of American biography) as to render some statement of them desirable for a generation to whom he was little known.

James Cooper, an English merchant, settled in New York shortly after the Revolution, accumulated a competency and died in 1801, leaving a son, William Cooper, born in 1798. At an early age the latter, who had inherited the love of nature from his mother, Frances Graham, determined to devote himself to the study of Natural History. At the age of eighteen young Cooper became one of the founders of the Lyceum of Natural History, now the New York Academy of Sciences, under the lead of Dr. S. L. Mitchill, John Torrey, Daniel Barnes and others, and soon became a generous contributor to its library and one of its officers. In 1821 William Cooper sailed for Europe to continue his studies in zoology and was elected the first American member of the Zoological Society of London. He attended the lectures of Cuvier at Paris, and on his return devoted himself to ornithology and paleontology. He was a friend of Schoolcraft, a correspondent and colaborer of Lucien Bonaparte, who dedicated to him the well-known *Falco Cooperi.* His son, James G. Cooper, was born June 19, 1830, and in 1851 graduated from the College of Physicians and Surgeons, New York, following it by a two years' course in the city hospitals. In 1853 he was appointed surgeon to the northern division of the Pacific Railroad Survey, at the suggestion of Professor S. F. Baird, and spent some time at the Smithsonian Institution, preparing himself for the duties

of naturalist as well as medical adviser to the party. He was one of the original group of young naturalists which gathered around Professor Baird in the early days of the institution, who made up the Potomac-side Naturalists Club, and whose names are classic in the annals of zoology in this country. Although never robust, and for much of his life in delicate health, he survived all the others. Dr. Cooper was assigned to the western division of the survey, terminating at Puget Sound, under the superintendence of Geo. B. McClellan, of the Engineer Corps of the army. Jefferson Davis was Secretary of War; the regimental quartermaster who supplied the needs of the party on the Pacific coast was U. S. Grant. Co-laborers with Cooper in working up the collections were Baird, Torrey, Asa Gray, Hayden, George Gibbs, Meek, Le Conte, and Dr. Suckley, in cooperation with whom Cooper prepared a report on the birds of Washington Territory. As usual in those days, he collected in all branches, and made a particular study of the meteorology of the region. The following year he returned to Washington to prepare his report, but was soon obliged by lung trouble to return to the more favorable climate of the Pacific coast. For several years he devoted himself to making collections on the Pacific coast, much of the time at his private cost. During the latter part of the Civil War he was surgeon in the 2d Cavalry, California Volunteers, and served until the regiment was mustered out. In 1865 and 1866 he was naturalist to the Geological Survey of California, under Whitney, and his report on the birds of the state, after the close of the Survey, edited by Professor Baird, was published by Professor Whitney at the personal cost of the latter, though in form as one of the 'Reports of the State Geological Survey.' In 1866, Cooper married Miss Rosa M. Wells, and continued in the practice of his profession until the failure of his health in 1871, after which his work, though often interrupted, was still pursued as his strength permitted. He was long associated with the California Academy of Sciences, and also with the State Mining Bureau. Much of Dr. Cooper's early work was of great help and importance in developing knowledge of the fauna, flora and geology of the Pacific coast. Ornithology knows him as a valuable contributor, and his most extensive works were on that branch of science. Later he published many papers on the mollusks of the coast, and the number of titles in this line of research mounts up to forty-three. Many of the younger students of zoology on the Pacific coast have testified to their appreciation of his help in guiding and promoting their studies. The Cooper Ornithological Club of California was named in his honor, and the first number of its *Bulletin* contains a sketch of his life, up to 1899, and a portrait. To this summary we are indebted for many of the above facts. Dr. Cooper was tall and slender, rather reserved in manner, and his physical activity was held in check by ill health during much of his life, while for years he was dependent upon his medical practice for support. But in spite of these handicaps his work on the Pacific coast has been of primary importance, and by his death passes away the last member of a group of men to whom American zoology is permanently indebted.

WM. H. DALL.

SCIENTIFIC BOOKS.

The Principles of Inorganic Chemistry: WILHELM OSTWALD. Translated with the Author's Sanction by ALEXANDER FINDLAY. London, Macmillan & Co. 1902. 8vo. Pp. xxvii+785.

Professor Ostwald has played a most prominent part in the promulgation of modern physical chemistry. His pen has been so wonderfully prolific that astonishment is felt that he is able to produce so many books of large size

while he is at the same time performing laborious investigations, editing the *Zeitschrift für Physikalische Chemie,* and doing the large amount of teaching that falls to his lot.

The work under consideration appeared in Germany about two years ago, and the recent appearance of a good translation of it is to be heartily welcomed, for in many respects this is a noteworthy and useful book. The English edition does credit to the publishers in being a handsome book, which, as it happens, is more attractive than the German one.

We have here an attempt to introduce a good deal of physical chemistry into the teaching of elementary inorganic chemistry. While this aim is a praiseworthy one, to some extent at least it appears to the reviewer that Professor Ostwald has gone somewhat too far in this direction. The book seems to be too difficult for any but mature and highly talented beginners. However, for chemical students of considerable experience, and in fact for a very large number of chemical readers the work will undoubtedly be valuable, for it contains clear and simple explanations of the points of physics that every educated chemist should know. Many physical matters are treated in a very interesting and suggestive way.

So much has been said in praise of the book that a few adverse criticisms may be allowed. In the first place, one important reason why the work would be difficult for a beginner is the fact that the author, while admitting that the atomic hypothesis is of great value for the purposes of instruction and investigation, avoids the use of this and of the molecular hypothesis as far as 'the present usage of language will permit.' His reason for so doing is that these are hypotheses, not realities. If he were consistent he would not use the ionic hypothesis, but he employs the latter to the last degree, and even occasionally alludes to ions in solid substances. The question may well be asked, can ions be assumed to exist without the assumption that atoms and molecules exist? The attitude of certain physicists in abandoning the atomic and molecular theories must appear absurd to chemists until something better is brought forward to replace those theories, for, what could an organic chemist do, for example, if he gave up atoms and molecules?

Another fault of the book is the occurrence of too many inaccurate statements. The translator says that the mistakes that had crept into the German edition have been, as far as possible, corrected; but still many remain that have been noticed, and it may be inferred that there are others which the reviewer was not wise or diligent enough to detect. A few examples will suffice to show the character of the errors.

The statements in regard to the amounts of carbon in iron and steel are contradictory and incorrect (pp. 563, 564, 585). The erroneous statement is made that sulphur can be readily removed with carbon and silicon in the ordinary Bessemer process (p. 585). Talc, which contains water, is given as an example of an anhydrous silicate of magnesium (p. 537). It is stated that the most frequent types of the double salts of antimony trichloride and triiodide are M_2SbCl_6 and $MSbI_4$ (p. 700), whereas these are rather rare types in both cases. Lead tetracetate, which is white, is called yellow (p. 652).

The translator's work has been very well done. One typographical error, which is not copied from the original, is noticed (p. 463) where 42,400 c.c. instead of 22,400 c.c. are given, which makes the volume of gas produced by the explosion of gunpowder altogether too large. In the table showing the periodic arrangement of the elements the translator has corrected the atomic weights of krypton and xenon, according to recent determinations, from 45 and 65 to 82 and 128, but, curiously enough, he has left the new numbers in the old places instead of putting them in the places called for by their magnitudes. The translator has introduced some curious names for ions, such as potassion, lithion, triferrion, carbanion, sulphanion, etc. As long as these are self-explanatory there can be no serious objection to them, but without having mastered the nomenclature one might be in doubt whether the last, 'sulphanion,' referred to the sulphide, sulphite or sulphate ion.

H. L. Wells.

NEW TEXT-BOOKS IN PHYSICS.

Physics for High School Students. By HENRY S. CARHART and HORATIO N. CHUTE. Boston, Allyn & Bacon. 1902.

Physics; a Text-Book for Secondary Schools. By FREDERICK SLATE. New York, The Macmillan Company. 1902.

Principles of Physics. By FRANK M. GILLEY. Boston, Allyn & Bacon. 1901.

A Laboratory Manual of Physics. By HENRY CREW and ROBERT R. TATNALL. New York, The Macmillan Company. 1902.

Physical Determinations. By W. R. KELSEY. London, Edward Arnold; New York, Longmans, Green & Co. 1902.

No criticism of a school text-book can be quite fair without a clear apprehension of the author's point of view, which may differ quite radically from that of the critic. In the absence of an opportunity for personal interchange the critic has no resource but to judge from his own standpoint, incurring the risk of appearing to indulge in too much praise or too much censure, in proportion to the degree of accordance or discordance between himself and those whom he wishes to treat with justice.

The first of the group of books named is a new and wholly rewritten edition of a text-book issued nearly ten years ago, which has been extensively used. Each of the authors had already become well known as an expositor, the one in the university and the other in the high school. Each holds firmly to an opinion, which has been repeatedly expressed in print by the present critic, that in physics the class room and the laboratory should be provided with separate books, which may be equally necessary to the student. That intended for the class room should be confined to a clear, well-methodized presentation of principles, accompanied with a goodly number of well-graded numerical problems. There may be outline descriptions of experiments, but only of such as are suitable for class room demonstration, to be performed by the teacher. For the elementary laboratory, on the contrary, the student needs a manual in which the instructions are chiefly for his guidance in manipulation. The class book is not a mere reading book. Its use is necessarily accompanied with much oral discussion by the teacher, and for this provision should be made in the text by much judicious omission of details. According to prevailing American usage the class book serves as the basis of much recitational work, and in its preparation this end should be kept always in view. No modern teacher will merely 'hear lessons' from it; but for convenience in actual use a well-arranged text-book is an important aid; and one that is written by even a fine scholar without the teacher's instinct or experience may be a source of keen suffering to its user, whether young or old.

Messrs. Carhart and Chute have been particularly successful in fulfilling these conditions in this new edition of their class text-book. The amount of mathematical preparation expected of the student is small, but formulas are introduced enough to make him appreciate their value in the solution of problems. Illustrations are sufficiently numerous, always simple, and none of them superfluous. Both metric and British systems of units are employed, the preference in general being given to the former. The book is well arranged, with many short paragraphs and suggestive headings; and its statements are clearly and carefully worded. It is worthy of unreserved commendation.

The volume by Professor Slate was prepared for California high schools, and in some particulars its aim is perhaps a little higher than can be reached by many of those for whom it was written. The style is discursive, such as might be adopted by a lecturer who is accurate and conscientious, but who does not emphasize salient ideas to any great degree. In arrangement the subdivision is not so clean cut as in the volume by Carhart and Chute, and long paragraphs are frequent, but the reasoning is generally good and suggestive. The book may be regarded as the reproduction of a series of well-prepared lectures, without the interruption of experimental details. An admirable outline of experiments, intended to aid the teacher, is reserved for the latter part of the volume. This includes many references to Chute's 'Practical Physics,' to which the

author offers a deserved tribute. Another valuable feature is the list of references for collateral reading, the outcome evidently of long-continued use of the note-book in the author's own reading. The order of presentation of the successive topics is a little different from usual, and out of 346 pages only 49 are devoted to magnetism and electricity, including 5 closing pages on electrostatics. Formulas are but sparingly employed and no problems are offered. To many this may seem a distinct element of weakness.

Mr. Gilley's book is a mixture of class text-book with laboratory manual, and as such it may be commended to those who are partial to such a mixture. The opening chapter treats of density, both experimentally and theoretically, density being defined as the quotient of weight by volume. This identification of mass and weight is convenient, but obviously not always allowable. Much space is occupied with minute instructions and precautions for the guidance of the student in manipulation, and there are many indications that the author is ingenious and energetic as a teacher. He has introduced many well-chosen problems, and his theoretical discussions are generally satisfactory. Like Professor Slate he gives scant attention to electrostatics, less than 4 pages out of 530 being thus devoted to 'surface electricity.' For elementary students this plan has much to commend it. Much of what passed for school instruction in the subject of 'frictional electricity' a half century ago was mere trifling; and such theoretic discussion as can now be given about it requires greater maturity than that of the high-school student.

Passing now to a manual which is not a mixture but intended exclusively for the laboratory, the high-school guide by Professor Crew and Dr. Tatnall is exceedingly good. Only simple exercises have been selected, involving for the most part apparatus that is commonly in use or fairly inexpensive if specially made. Nearly every exercise is introduced with references to one or more of seven elementary text-books in which the student may find a discussion of the theory involved. Then comes a list of the apparatus to be used; a clear statement of the problem to be experimentally solved; such instructions as are needful for the manipulator; and, finally, in the earlier part of the book, tabular forms are given to aid the student in acquiring methodical laboratory habits. These forms are discarded for the most part after the second chapter. Some of the exercises are merely qualitative, especially in electricity. Of those that are quantitative some will perhaps be welcomed not only in the high school, but for beginners in institutions that assume more pretentious names.

Kelsey's 'Physical Determinations' are intended for students of rather more advanced grade, having been written for a technical school. The author's aim was 'to supply outline directions which might enable a class of students to proceed with work until the demonstrator could give individual instruction to each group.' Discussion of detail is hence omitted, and to such an extent that the book does not seem destined to meet 'a long-felt want' in very many American laboratories, in view of the considerable number of more helpful books of this kind already in the American market. The explanations of theory are not always very clear, inconveniently long steps being occasionally taken; nor are the instructions about manipulation sufficiently full to warrant the student in making much headway with his work while impatiently waiting for the arrival of the demonstrator. Nevertheless the book would never have been prepared had not its material served a useful purpose in the laboratory for which it was intended.

W. LeC. Stevens.

Washington and Lee University,
July 25, 1902.

SOCIETIES AND ACADEMIES.

RESEARCH CLUB OF THE UNIVERSITY OF MICHIGAN.

Since last reported, the club has held two meetings. At the first meeting Professors Russell and McMurrich gave papers; the former, using lantern slides, detailed his explorations in Idaho last summer, and the latter addressed the club on the phylogeny of the muscles of the human forearm. At the last meeting of the year, held in May, Professor Craig explained the process by which

the Assyrian inscriptions were deciphered, and Professor Vaughan gave the results of a long series of experiments made during the past two years by his students and himself in endeavoring to ascertain the nature of the specific bacterial toxins. An abstract of this paper will be published in SCIENCE.

FREDERICK C. NEWCOMBE.

DISCUSSION AND CORRESPONDENCE.

SIX NEW SPECIES.

TO THE EDITOR OF SCIENCE: There has just come to my attention a copy of the 'Ninth Annual Report of the Ohio State Academy of Science,' for the year 1900. Although apparently published in 1901, it contains one article that is still deserving of wider notice! This is a paper on 'Six new Species, Including two New Genera, of Fossil Plants,' by H. Herzer, the reading of which is calculated to cause mixed reflections, alike to the student of English and the paleobotanist. His first species, quoted entire, reads as follows: 'Palæophycus clavifrons. Nov. Spec. A much ramifying marine weed, shooting at once at sharp angles a number of branches, which at distant intervals multiply again in the same manner. Each branch seems a barren, rugged cylinder, beginning at its outgrowth thin as twine, then assuming a thickening of $\frac{3}{8}$ inch, giving the rather lengthy branches a club-like form.—Sandstone flagging, Harmar Hill, Marietta, Ohio."

Of his 'Caulopteris magnifica, Nov. Spec.,' he says: "Among the numerous silicified remains of plants of the carboniferous age, from Athens County, Ohio, that have been liberated out of the Mahoning sandstone, we find quite a variety of species grouping under different genera, which are by their internal organization closely allied to each other. The great interest in these thus preserved plants is presented in the minute preservation of internal structure by which their classification is greatly facilitated and at once obvious. * * * Our species here is a well-preserved, magnificent treefern, once beautifying the unbroken wilds of its time"!!

"Psaronius junceus, Nov. Spec. As has been shown in one of our former meetings, Psaronius is not a conical stalk of aerial roots, enclosing the base of tree-ferns, but is a plant *per se*. We present the one before us as a new species, having in its central arrangement the structure of a fern or a Sigillaria or likely a Lepidodendron; for all these characters are closely allied to one another; but also being remarkably made up of cellular fascicles, enclosing like individuals that center and joining one another so densely, as to have no interstinct tissue between them. Each fascicle is throughout the whole trunk, which attains the thickness of 1½ in., as thin and slender as bulrushes, from three sixteenths to one eighth inch thick, crowding each other in various angles. In each fascicle is a star-like center of coarse woody cells, surrounded by small circular cells. The main center two inches in diameter and being a pithy cylinder, has the same long vermicular woody bundles as are common to the above mentioned trees."

This is undoubtedly a new species, if not indeed a new order. The absence of 'interstinct tissue' settles that!

The first mentioned of the so-called new genera (*Cystiphycus*) is introduced by the lucid statement that 'Like many other fucoids this species had the same mode of growth.' The other may be quoted entire. "Nodophycus thallyformis [*sic*], a New Genus. The fronds of this seaweed must have been very large. I find them covering large slabs of sandstone. The nodose elevations of the frond are from one third to one half inch apart and look as if a soft thallus had spread over peas"!

The first mentioned 'new' genus is incorrectly formed, etymologically, and both generic and specific words in the other are hybrid Latin and Greek combinations. Can anything be worse?

I submit that not one of these descriptions is adequate or even intelligible, and, with the possible exception of the *Caulopteris,* the figures are as bad. Those illustrating *'Palæophycus clavifrons'* and *'Nodophycus thallyformis'* might, with equal propriety, be used to illustrate a paper on meteorites.

In the name of paleobotanists I protest against such solecisms as these being con-

sidered a part of our science. Paleobotany has legitimate troubles enough of its own without being taxed with this. It is difficult to understand how the publication committee of the Ohio State Academy of Science could have admitted this paper, at least in its present form.

F. H. Knowlton.

GEOLOGICAL EXCURSIONS IN THE PITTSBURGH COAL REGION.

The Pittsburgh meeting of the Geological Society of America and of Section E of the A. A. A. S. was rendered memorable to many geologists by the opportunity afforded them to study the stratigraphy of the bituminous coal fields of Pennsylvania and West Virginia, under such an experienced and enthusiastic guide as Professor I. C. White. About twenty geologists and students assembled at the Pennsylvania station on Tuesday morning, June 24, for the 6.15 train. The first objective point was Garver's Ferry, opposite Freeport, on the Allegheny River. This is the type locality for the Upper and Lower Freeport coals, and these with their accompanying shales, fire-clays and sandy beds were studied. An interesting feature was the occurrence of limestone beds in this coal series, which in some cases lay directly beneath the coal, and in others were associated with the fire-clay. Frequently both fire-clay and limestones were replaced by the sandstones of the series.

The Freeport sandstone underlying the coal series was seen in the river bed. The lowest member of the Conemaugh or Lower Barren series in this region is the Mahoning sandstone group, which often includes a thin seam of coal (Mahoning) and sometimes calcareous beds. The overlying Masontown coal and the red beds higher up, nearly to the horizon of the Crinoidal limestone, were studied in a walk of several miles and a climb up the steep rocky cliffs. This brought before the party the entire lower half of the Conemaugh, up to the horizon of the rocks exposed at Pittsburgh. The upper portion of the Allegheny or Lower Productive series (Freeport coal group) was also included. At Kittanning, further up the river, the study of the Allegheny series was taken up again, and this time nearly the entire series was seen from the Clarion Coal, twenty-five feet above the Pottsville, to the Upper Freeport coal, and also the overlying Mahoning sandstones of the Conemaugh series. Special attention was called to the Ferriferous limestone and the Kittanning coals in this section. Still farther up the river at the mouth of the Mahoning, the greater portion of the Pottsville series as brought up by the Kellersburg anticlinal, was studied. The lower or Connoquenessing sandstone with its included Quakertown coal, and the upper or Homewood sandstone with the intermediate Mercer coal groups, were pointed out.

On the return journey a stop was made at Crag Dell and a short walk along the railroad tracks enabled Dr. White to point out many of the interesting detailed characteristics of the Upper Freeport coal and its associated rocks.

On Wednesday the party visited the interesting region about the junction of the Connoquenessing with the Beaver, and here the Homewood and Upper and Lower Connoquenessing sandstones were studied at their type localities. Some of the lower members of the overlying Allegheny series were also studied, especially the Ferriferous limestone. Later in the day, near Beaver, the Brookville and Clarion coals with the intervening Eagle limestone were seen, thus completing the base of the Allegheny series.

The interesting glacial phenomena along the Beaver, below the terminal moraine, were given special attention, and the evidence of the former impounding of the waters in the preglacial river valleys of the Ohio and its tributaries by the front of the ice sheet, as pointed out by Dr. White, was pronounced very conclusive. Attention was also given to the character of the preglacial valleys, and the high-level terraces on either side of the Ohio and the Beaver, and their gradual descent northwestward, forcibly suggested the former northwest drainage into the Lake Erie Valley of the river systems of this region, as pointed out by White, Hice and others.

These terraces were again seen along all the larger streams of this region which were visited during the week, and the evidence of the impounding of the waters in all of these valleys, up to the level of 1050 A. T., was found to be very striking and conclusive. (The details concerning these high gravels have been given by Dr. White in several papers.) Thursday morning was devoted to a study of the stratigraphy of Pittsburgh city, where the whole upper portion of the Conemaugh series from the Crinoidal limestone—which is finely exposed in many portions of the city—to the Pittsburgh coal, the basal member of the Monongahela or Upper productive measures, is exposed.

The Pittsburgh coal is mined along the summits of the hills in Pittsburgh and has become the chief source of the city's natural wealth. The high level terraces and gravels were again pointed out.

In the afternoon the novel experience of witnessing the shooting of an oil well was enjoyed by the party. For this experience the party is indebted to the McDonald Oil Company. Later the Jumbo coal mine in the neighborhood was visited, where, under the guidance of Dr. White and mine foreman Campbell, the mining of the Pittsburgh coal was inspected.

On Friday several additional outcrops of the Pittsburgh coal bed in the vicinity of the city were visited, and then a trolley ride to McKeesport enabled the party to visit the old high-level oxbow of the Youghiogheny. The high-level terraces and their gravel deposits were again the chief subject of study, and in the afternoon a visit to Monument Hill, in Allegheny, an isolated remnant of the ancient river bottom, furnished additional opportunity for the study of these features.

On Saturday the party left Pittsburgh for a two days' excursion. The first stop was made at Connellsville, where the coking of the Pittsburgh (Connellsville) coal is carried on extensively. Various coke ovens were visited under the guidance of the officials. The entire Conemaugh, Allegheny and Pottsville series were here passed over in a short space, owing to their elevation in the anticlinals flanking the Connellsville basin. The Mauch Chunk, Greenbrier and Pocono formations were also seen and the outcrops of the upper Devonian were pointed out. At Uniontown the higher members of the Monongahela, and the lower members of the Dunkard up to the Washington coal were passed through in the deep mine of the H. C. Frick Company, where the Pittsburgh coal is mined at great depth. Many of the strata above the Pittsburgh coal were also observed in the various outcrops. Sunday was spent in Morgantown, W. Va., and a drive to Cheat River canyon enabled the party to study the continuation of the high-level rock terraces and their washed gravels, which clearly indicated the extent of the great ice-dammed lake which Dr. White has traced out in these valleys. The revived topography of the region and the Cheat canyon across the Chestnut ridge anticlinal gave opportunity for discussion, and as the rain interfered to some extent with the field work, the members of the party were treated to a careful description of the structure and topography of the region by Dr. White, whose intimate familiarity with the region enabled him to speak with authority on the subject.

Through the exertions of Dr. White the trip to Morgantown and return was made complimentary by Superintendent Haas, of the Baltimore and Ohio Railroad at Pittsburgh. On Saturday the party was entertained in the most liberal manner by the Frick Coke and Coal Company through its manager, Mr. O. W. Kennedy. Everything was done to make the excursion interesting and profitable. At Morgantown all the members of the party were the guests of Dr. White, to whom they were already so deeply indebted for his constant readiness and eagerness to explain the phenomena encountered, and his untiring effort to make the week, what it certainly has been, one of unparalleled success and enjoyment. The week's work was most pleasantly wound up by a reception given by Dr. and Mrs. White and the other members of their hospitable family at their beautiful home, 'Cherryhurst.' Here the geologists had the opportunity of meeting many of the promi-

nent citizens of Morgantown and a number of the officers of the University of West Virginia.

The following is the list of persons who attended one or more of the excursions:

I. C. White, Morgantown, W. Va., leader; J. R. Macfarlane, Pittsburgh, Pa., assistant leader; H. L. Fairchild, University of Rochester; B. K. Emerson, Amherst College; C. R. Eastman, Mus. Comp. Zool., Cambridge; J. B. Hatcher, Carnegie Museum, Pittsburgh; F. B. Peck, Lafayette College; C. S. Prosser, Ohio State University; A. E. Turner, President Waynesburg College; A. R. Crook, Northwestern University; U. S. Grant, Northwestern University; Florence Bascom, Bryn Mawr College; G. C. Martin, Johns Hopkins University; A. E. Ortmann, Princeton University; A. W. Grabau, Columbia University; H. W. Shimer, Columbia University; Miss Ida H. Ogilvie, Columbia University; R. R. Hice, Beaver, Pa.; J. C. Williams, Ridgeway, Pa.; Miss L. K. Miller, Groton, Mass.; F. H. Oliphant, Oil City, Pa.; D. E. Crane, Sewickley, Pa.; A. S. Coggeshall, Carnegie Museum; L. S. Coggeshall, Carnegie Museum; Sidney Prentice, Carnegie Museum; Claude McD. Hamilton, of the *Pittsburgh Despatch*, Pittsburgh.

Amadeus W. Grabau.
Columbia University.

SCIENTIFIC NOTES AND NEWS.

M. Bouvier has been elected a member of the Paris Academy of Sciences in the section of anatomy and zoology in the room of the late M. Filhol.

Professor Angelo Heilprin sailed on the 12th instant for the West Indies to complete his observations on the volcanoes of Martinique and St. Vincent.

Gen. A. W. Greely, chief of the U. S. Signal Service, has returned from Alaska, where he had been inspecting the work on the Government telegraph line from Valdez to Eagle City.

The daily papers report that President David Starr Jordan has been successful in securing a valuable collection of fishes in the Bay of Apia, Samoa, some four hundred and fifty species, many of them new, having been collected.

A party, under the direction of Professor Birksland, has left Copenhagen for Nova Zembla to study the aurora borealis during the summer.

Professor W. E. Ritter, of the University of California, has secured funds for the erection of a marine laboratory at San Pedro, which will be used as a center for the biological study of the Pacific coast.

Lieutenant W. E. Safford, U. S. Navy, has resigned his commission in order to take the position of assistant curator in the Bureau of Plant Industry of the Agricultural Department. His specialty will be tropical botany. Mr. Safford has been engaged for many years in collecting material and information relating to useful plants of the countries visited by him in cruising.

Robert L. Randolph, M.D., associate professor of ophthalmology and otology in the Johns Hopkins Medical School, has recently received the Boylston prize for a paper entitled 'The Rôle of the Toxins in Inflammations of the Eye.'

The Paris Society of Geography has conferred its Ducros-Aubert prize on Dr. Huot, a physician in the French colonies.

Dr. Martin Ficker, custodian of the Museum of Hygiene of the University of Berlin, has been appointed director of the Hygienic Institute.

The Advisory Committee of Public Hygien of France has elected as members MM. Ed. Bonjean, Thierry, Binot, Brouardel, Boulloche and Courtois-Suffit.

We learn from the *American Geologist* that a bust of the late Dr. Edward W. Claypole has been placed in the assembly hall of the Throope Polytechnic Institute. The presentation address was made by President W. H. Knight, of the Los Angeles Academy of Sciences, and it was accepted by Dr. Norman Bridge for the board of trustees.

Dr. William S. Bradshear, president of the Iowa State College at Ames, died on August 4, at the age of fifty-two years.

The deaths are also announced of Dr. W. Iveson Macadam, lecturer on chemistry in the School of Medicine of the Royal Colleges of

Edinburgh, and of Dr. P. M. Garibaldi, professor of physics at Genoa.

MR. ANDREW CARNEGIE has given £10,000 to build a free library at Cork, Ireland.

THE University at Tomsk has received a gift of one hundred thousand roubles for the establishment of a biological station.

THE Berlin Academy of Sciences has announced that its academic prize, 5,000 Marks, will be awarded in 1904 for an investigation of the kathode rays and in 1905 for an investigation of the theory of functions of several variables which admit of linear substitution. The income of the Cothenius legacy—$2,000—for 1904 will be awarded for investigations on new varieties of grain. The papers may be written in English and must be presented without the name of the author to the Bureau of the Academy, Universität Strasse, 8, Berlin.

STEPS are being taken for the establishment of a medico-historical department in the Germanic Museum at Nürnberg on the occasion of the fiftieth anniversary of its foundation. It will contain a collection of medical and surgical instruments and apparatus, drawings, portraits, books and manuscripts, illustrating the history of the art of healing.

THE British Medical Association held its seventieth annual meeting at Manchester, beginning on July 29. The business of the Association was conducted in seventeen sections which held their meetings at Owen's College. There were somewhat over 1,500 members in attendance. The meeting next year will be held at Swansea under the presidency of Dr. Griffiths.

THE first conference of the International Bureau for combating tuberculosis will meet at Berlin from October 22 to 26.

THE German Society for Mechanics and Optics, consisting of those engaged in making instruments of precision, will this year meet at Halle on August 15, 16 and 17.

THE Paris correspondent of the London *Standard* states that the Ministers of Foreign Affairs and Agriculture, just before the summer recess, presented to the Chamber a bill approving the international convention for the protection of birds useful to agriculture. The international convention has been signed by eleven European states. Encouraged by the constantly renewed resolutions of the Councils General and the agricultural societies, which deplored the systematic destruction of certain birds useful to agriculture, the French Government, in 1892, took the initiative in the matter by inviting the European powers to send their representatives to an international commission intrusted with the task of elaborating a convention. That committee met in Paris in June, 1895. After long negotiations the convention thus framed has now obtained the adhesion of France, Germany, Austria, Belgium, Spain, Greece, Hungary, Luxembourg, Portugal, Sweden, Switzerland, and the Principality of Monaco. All the other states are empowered by the terms of the agreement to adhere, if they think fit, to this convention for the protection of birds. The various contracting governments undertake to prohibit the employment of snares, cages, nets, glue, and all other means for the capture and destruction of birds in large numbers at a time. In addition to this general measure of protection, no one is to be allowed to capture or kill, between March 1 and Sept. 15, any of the birds useful to agriculture, and of which a complete list is contained in the international agreement. This list of useful birds comprises sparrows, owls, common brown owls, tawny owls, sea eagles, woodpeckers, rollers, wasp-eaters, pewits, martins, fern owls, nightingales, redstarts, robin redbreasts, white bustards, larks of all kinds, wrens, tomtits, swallows, flycatchers, etc.

A LINE of work recently taken up by the Bureau of Forestry, and for the first time receiving adequate attention in the United States, is the study of the tendency of natural forests to extend over the land devoid of forest growth. This tendency has been noticed in many parts of the country, but has never been studied with a view of controlling it for practical use, or assisting it where desirable. A field party from the Bureau is now investigating the reproduction of white pine on

pastures and abandoned lands in Massachusetts and New Hampshire, to learn the conditions under which reproduction takes place. The Bureau is making this investigation in order to be able to give owners of such lands directions as to the best methods of handling them, with a view of securing a stand of pine by natural seeding. A field party of six men is studying the same problem in Oklahoma, in connection with hardwood growth which composes the timber belts of that region. It has been found in certain places in the middle west that natural forest belts have extended up streams as much as two miles in the last twenty-five years. Particular attention will be paid to devising methods for extending and improving the forest growth of the Wichita Forest Reserve, where at present the stand of timber consists of only a scattering growth of oak. A similar study is being made on the Prescott Forest Reserve in Arizona, where the stand of timber consists almost entirely of Western yellow pine. For several years only a scant reproduction has taken place on this reserve, and one of the objects of the present investigation is to devise means of increasing the stand of young timber.

Among the important economic studies now being conducted by the United States Geological Survey in the region east of the Mississippi River is the investigation of the coal field within the first district in southwestern Indiana, the results of which will appear before the close of the year. The area covered to date embraces nearly 1,000 square miles, and includes portions of Pike, Gibson, Vanderburg, Warrick, Spencer and Dubois counties. The Survey has prepared unusually accurate topographic maps, showing not only the houses, highways, railways, town and county boundaries, and drainage features, but also, by means of contours, the heights and shapes of the hills. The geologic maps, which are being prepared by Messrs. M. L. Fuller and George H. Ashley, will show the outcrop of the 'big' or Petersburg coal vein from near the White River to the vicinity of the Ohio. Its approximate elevation above sea level will be shown both along its outcrop and beneath the surface, giving a basis from which its depth below the surface can be calculated at any point. The locations of the mines are also shown. The outcrop of the smaller coal, designated 'No. 7' by the Indiana State Survey, which occurs above the Petersburg coal, will be shown in the same manner, as will also some of the coals beneath the latter. The maps will be accompanied by an account of the geologic history of the region, by descriptions of a number of important drainage changes, and by a detailed description of the character and structure of the rocks, especially of the coal. The maps described are the first installment of a series which will later be extended westward into Illinois and southward into Kentucky.

The United States Geological Survey has recently completed a study of the oil fields of California, which of late years have become so important an economic feature of that State. The investigation was conducted by Mr. George H. Eldridge, one of the geologists of the Survey, who is now engaged in the preparation of a report. This report, which will later be available to the public, will contain information of interest regarding the geologic conditions governing the occurrence of oil in the California district. During the year Mr. Eldridge will also complete a report on the phosphate deposits of Florida, upon which a portion of his time has recently been spent.

Mr. George F. Lincoln, Consul-General of Antwerp, writes to the Department of State that the Cartographic, Ethnographic and Maritime Exposition was opened to the public on May 22. The Royal Geographical Society of Belgium has obtained for the purposes of this exhibition the assistance of the French, Dutch, Spanish, Italian and Mexican Governments, and in addition the Queen has sent many interesting objects from her private collections. The exhibition of ancient and modern charts, atlases, maps, globes and projections is perhaps the most interesting that has ever been brought together, and is particularly notable for its fine specimens of the works of Mercator, Ortelius, Blaeu, Hondius and the val-

uable display of those of Elisée, Reclus, the great geographer of modern times. The charts of the Ka-Tanga scientific expedition here find a place, as well as the various scientific apparatus used by the members of the mission. There is a fine map of the Lower Kongo and some remarkable relief maps of the Suez and Panama canals, the districts of Lake Geneva and the Matterhorn, as well as a large one of the surface of the moon. The ethnographical section comprises photographs, weapons, household utensils, religious objects, articles of wearing apparel, etc., from the Kongo Museum at Terveuren, from missions in the Kongo, China, Java and South America, besides a brilliant display of gods and goddesses from the Dutch East Indies and beautiful tapestries from the royal palace at Pekin. In the maritime section are models of the newest types of ocean liners, furnished by the principal steam navigation lines; models of old Dutch craft and men-of-war, and of the proposed ports at Ghent, Brussels and Heyst; souvenirs of the explorations of the Duke of Abruzzi, of the Belgian Antarctic expedition, etc. A number of improved instruments for studying the depths of the sea, life-saving apparatus, and instruments of precision for exploring, prospecting and surveying purposes, besides astronomical instruments, complete an exhibition that is highly interesting from both an educational and scientific point of view.

Nature states that at the meeting of the London County Council on Tuesday the Technical Education Board reported the result of the inquiry by a special subcommittee of the board as to the need and present provision for special training of an advanced kind in connection with the application of science (especially chemistry and electricity) to industry, and as to what, if any, developments are needed to secure efficient training in these subjects for senior county scholars and other advanced students who desire to qualify themselves to take leading positions in scientific industries. The report of the special subcommittee deals with matters which the board points out are of great importance to the present and future prosperity of various English industries, notably some connected with London. The members of the special committee came, without a dissentient voice, to the conclusions (1) that England (and London in particular) has suffered the loss of certain industries and that others are in danger; (2) that this loss has been largely due to defective education, especially in the higher grades; and (3) that London is still seriously behind other cities, notably Berlin, in the provision for the higher grades of scientific training and research. The report was accepted, with the addition of the recommendation 'that the Technical Education Board be instructed to report as to the steps it proposes to take in order to give practical effect to the suggestions contained in the report.'

THE *Electrical World* states that Arizona has several large and very important water power projects under construction. Lack of rain in the southwest serves as a great hindrance to development of water storage and developments in water power. In the Salt River Valley the towns of Phœnix, Tempe and Mesa are lighted with electricity, generated by small falls in the valley's canal systems. Sixty miles southeast of Prescott, on Fossil Creek, work has begun on a scheme that is destined to develop 2,000 horse-power, to be used mainly in the mines of central Yavapai County. A great power project is in incubation, based upon the damming of Bill Williams Fork, in extreme western Arizona. The new dam that is to store flood waters for the use of the Salt River Valley is to be built largely with the aid of water power, and a few miles above the reservoir it will supply power for a 3,000-h. p. transmission line to Globe and other central Arizona mining camps. This plant is being built by C. M. Clark. The Grand Canyon of Arizona affords the greatest field for electricity generated by water power. Below the new Santa Fé Hotel, on the canyon brink, are Indian Garden Springs, which, in ordinary seasons, have a flow of nearly 100 miners' inches, that can be thrown over a cliff 3,000 feet high. In Cataract Canyon, the stream of flow usually approximating 10,000 miners' inches, makes three great leaps of 70,

144 and 250 feet, respectively, without reference to several thousand feet of drops from the Indian villages to the Colorado's channel. Many plans have been mooted for developing the marvelous power of the Colorado, a stream which rises as much as 100 feet in flood time within the canyon. Floats equipped with great paddle wheels have been suggested, but it is probable that the river will some day be harnessed by means of tunnels that will 'pick up' the fall of the stream. One such tunnel, at a point near Bass's Trail, and not over half a mile in length, driven through black granite, would cut off 12 miles of river channel, averaging not less than 12 feet of fall to the mile. Dr. A. J. Chandler, of Mesa, Arizona, is engineering the latest Grand Canyon power plant. Dr. Chandler is the manager of the southwestern interests of Bowen & Ferry, the Detroit capitalists, and has made a success of a power-generating plant near Mesa. He has found an ideal location for power-generating works on the Kanal, Wash., not far from its union with the inner canyon of the Colorado about 70 miles north of Williams. It is stated that even 5,000 feet of fall can be found in a distance a little over a mile. The water supply is said to be ample and of remarkable regularity of flow. The only question seems to be that involving the carriage of the necessary heavy machinery down into the canyon and across the river, unless it be hauled southward from some Utah railroad point and lowered over the precipitous cliffs.

UNIVERSITY AND EDUCATIONAL NEWS.

The University of Toronto has arranged its academic course leading to the B.A. degree, so that when the student has completed four years of work he may have fulfilled the requirements of the first two years of medicine. He can then enter the third year of medicine and graduate in two years, thus making it possible to obtain the degrees of Bachelor of Arts and Bachelor of Medicine after six years of study.

A laboratory of experimental psychology will be opened next winter at King's College, London. It will be under the general supervision of the professor of physiology, Dr. Haliburton, and the special conduct will be entrusted to Dr. W. G. Smith, formerly of Smith College, Northampton, Mass.

The University of Jena will celebrate its three hundred and fiftieth anniversary in 1908. Arrangements are already in progress for the preparation of a history of the university based on unpublished documents.

Cornell University, through the generosity of Abraham Abraham of Brooklyn, has acquired the Egyptological and Assyriological library of the late Professor August Eisenlohr of Heidelberg.

The registration at the summer school of Columbia University is this year 643 as compared with 589 in 1901 and 417 in 1900, when the school was first established.

The State University of Iowa has created a chair of psychology and elected to it Dr. C. E. Seashore, at present assistant professor in philosophy. Dr. Seashore took his doctor's degree at Yale in 1895 and was assistant in the Psychological Laboratory from 1895 to 1897.

Robert S. Shaw, professor of agriculture in Montana, has been elected to the chair of agriculture in Michigan Agricultural College. He graduated at Guelph, Ontario, in 1892, managed his father's farm for four years, and took his father's classes for one year in the University of Minnesota.

L. B. Walton, A.M. (Brown, 1900), Ph.D. (Cornell, 1902), has been appointed instructor in biology at Kenyon College, Gambier, Ohio. He held last year the Goldwin Smith fellowship in zoology at Cornell University.

At Purdue University J. R. McColl, now of the University of Tennessee, a graduate of the Michigan Agricultural College, has been appointed associate professor of thermodynamics, and Mr. Fritz B. Ernst, now on the editorial staff of the *Railway Age* and a graduate of Purdue University, has been appointed assistant in car and locomotive design.